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The Mediation of Mycorrhizae in Constituting Association and Distribution Pattern of Some Plants in Murree Hills and Galliyats

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Abstract: A vegetation survey based on releve analysis was conducted in Murree Hills and Galliyats during autumn 1998 and spring 1999. The area was demarcated into eight stands in which various phytosociological parameters were recorded. During the tabulation of raw data, emphasis was laid upon the physical characteristics of the stands. Composite soil samples were collected to find out pH, organic matter, N, P, K, Ca^{++}, Mg^{++} and textural classes. Plant associations were identified based on chi-square analysis (including Yate's correction) and dominance of plants were based on highest importance values. *Urtica dioica* and *Rumex nepalensis* were having similar ecological amplitude and comprising an association among all stands. Mycorrhizal association supported the distribution pattern of both the species. *Rumex nepalensis* exhibited a healthy symbiotic association and was more mycorrhizal as compared to *Urtica dioica*. The soil where phosphorus contents were relatively lesser, a high degree of root length colonization by VAM fungi was observed. The give and take role of this association proved by arbuscular infection, which was intensely observed in the roots of *Rumex nepalensis*. In conclusion, it seems that climatic conditions are utilized by both the species in more or less similar way however, the dominance of *Rumex nepalensis* is a sign of better exploitation of soil nutrients aided by mycorrhizal fungi.

Key words: Mediation, mycorrhizal, fungi, *Rumex nepalensis*

INTRODUCTION

The naturally occurring vegetation can be used as a general indicator of environmental conditions and ecological processes. Another important use for studies of naturally occurring vegetation in undisturbed environments is that understanding of the synecology and dynamics of so-called intruders or exotic species will enhance better prediction about success ional trends. Many workers have presented the future trends of vegetation successional on the basis of exotic colonizers[1]. The data obtained from such results is also important from conservation point of view because it provides a clear picture of status of vegetation[2] particularly species under threat or on decline[3].

The area adjacent to Murree Hills is quite undisturbed. Herbaceous flora comprising of annuals and perennials grow vigorously under the shade of pine trees and add to the plant diversity. The area represents cold temperate climate and slopes of the hills presents a typical topographic picture. The indigenous natural vegetation is well adapted and acclimatization seems to be at zenith.

The universal role of soil fungi in modifying the ecosystem cannot be overemphasized. Majority of land plants especially forest species[4] count on mycorrhizal fungal association to take nutrients from soil. The soil fertility status particularly the phosphorus contents of the soil are very important in determining the colonization of vesicular arbuscular mycorrhizal (VAM) fungi among plants growing in any soil. Changes in the soil nutrient level have a direct influence on prevailing vegetation type. During succession, the response of plants to an increasing density of VA mycorrhizal propagules is confounded with their response to other changes that take place in soil such as accumulation of soil organic matter and nutrient storage capacity[5]. Various studies have revealed that plant succession due to soil disturbance have a marked effect on mycorrhizal fungi[6].

Therefore present study was conducted to find out any existing interspecific association among plant species in Murree Hills as well as in surrounding Galliyats and their causal interpretation based on edaphic attributes and VAM root colonization.

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MATERIALS AND METHODS

In the preliminary survey it was observed that *Rumex nepalensis* and *Urtica dioica* were growing together in different areas. On this basis eight different stands (2x2 km) were selected for study area. So the study was limited to area with these two species as dominant or co-dominant. Cover-abundance values of all species present were estimated according to the Braun-Blanquet scale, as given by Mueller-Dombois and Ellenberg[7]. To find out the correlation between two species index of association was used. Habitat parameters recorded were topography, slope, soil type and various soil properties including physical and chemical properties. The soil properties included percentage sand, silt and clay; soil nitrogen, phosphorus, exchangeable K^+, Ca^{++}, Mg^{++}, soil pH and organic matter contents[8] .

On the basis of highest association observed in different stands, selected association forming plant species were subjected to study vesicular arbuscular mycorrhizal colonization. Carefully collected roots of *Rumex nepalensis* and *Urtica dioica* from eight different stands were used for excavating the whole root system. These were washed, cut into 1 cm segments and stained in aniline blue. Percentage root length colonized by VAM fungi was determined[9].

Two-way analysis of variance was used to compare the responses of *Urtica* and *Rumex* to VAM colonization between them and among different stands. The Index of Association was subjected to Chi square test. StatView for windows was used for the analysis.

RESULTS

All the stands where vegetation analysis was conducted were having mainly porous soil to freely drained topography. The parent material was largely stony (Table 1). The *Rumex nepalensis* was more frequently found than *Urtica dioica* in all the stands except in one stand (Lawrence College Road) where the relative frequency of both the species was similar (Table 2). The other two parameters i.e., relative cover and relative density were in favour of *Rumex nepalensis* that has enabled the species to show high importance value. Furthermore, the frequent occurrence of both the species proved a high index of association and in all stands and a positive association value was observed (Table 3).

As far as total crown cover was concerned, in autumn 1998 out of eight stands, four were having less than 50% crown cover values. However, in spring 1999, six out of eight stands showed less than 50% crown cover values (Table 4). Results of the soil analyses are presented in Table 5. The soil pH values of all stands were slightly acidic and never reached the figure of 7.0. In the case of Dunga Galli (a), the maximum value of soil organic matter contents was estimated while Khanaspur soil exhibited

Table 1: Site characteristics of different stands

Stand's location	Altitude (meters)	Drainage	Deleterious effects	Coarse skeleton	Soil constitution
Dunga Galli (a)	2130	Deep freely drained	Trampling	Stony	Porous
Dunga Galli (b)	2130	Deep freely drained	Trampling	Stony	Porous
Ayubia	2160	Deep freely drained	Erosion Grazing	Stony	Compact Porous
Murree Pipe line	2140	Deep freely drained	Cutting Trampling	Stony	Porous
Khanaspur	2020	Deep freely drained	Cutting	Stony	Porous
Lower Topa	1940	Freely drained	Grazing	Stony	Porous
Kuldana	1960	Freely drained	Trampling Grazing	Gravely	Spongy
Lawrence College Road	1900	Freely drained	Cutting Grazing	Gravely	Porous

Table 2: Phytosociological parameters of the two associations component species in different stands

Stand's location	Plant species	Relative frequency	Relative cover	Relative density	Importance value
Dunga Galli (a)	*Rumex nepalensis*	15.13	33.80	25.94	24.96
	Urtica dioica	13.82	10.65	8.53	11.00
Dunga Galli (b)	Rumex nepalensis	15.86	44.59	33.51	31.32
	Urtica dioica	13.79	11.22	10.76	11.93
Ayubia	Rumex nepalensis	15.28	44.37	34.70	31.45
	Urtica dioica	13.19	11.19	11.61	12.00
Murree Pipe line	*Rumex nepalensis*	15.00	48.49	27.19	30.23
	Urtica dioica	13.57	14.33	9.69	12.53
Khanaspur	*Rumex nepalensis*	12.54	43.73	22.39	26.22
	Urtica dioica	10.83	13.05	8.77	10.88
Lower Topa	*Rumex nepalensis*	16.79	37.86	28.84	27.83
	Urtica dioica	15.33	20.79	11.91	16.01
Kuldana	*Rumex nepalensis*	16.06	41.99	23.49	27.18
	Urtica dioica	15.33	11.99	11.74	13.02
Lawrence College Road	*Rumex nepalensis*	13.77	42.41	34.24	30.14
	Urtica dioica	13.77	22.84	10.46	15.69

Table 3: Statistical analysis of chi square test and index of Association

Stand's	x^2	Index of association	+ve / -ve association
1	14.28	82.55	+ve
2	15.97	78.40	+ve
3	05.30	62.10	+ve
4	16.90	81.11	+ve
5	16.90	68.96	+ve
6	12.99	67.46	+ve
7	09.12	71.11	+ve
8	14.44	68.35	+ve

Degree of freedom (d.f) = 1

Table 4: Percentage values of overall crown cover in the study area sites

Sampling season	Stand number							
	1	2	3	4	5	6	7	8
Autumn 1998	44.3	35.4	43.3	53.3	59.3	53.6	65.3	33.1
Spring 1999	71.1	39.4	40.3	40.4	45.6	39.2	45.8	72.8

lowest organic matter i.e., 3.07%. The same situation revealed as far as moisture percentage is concerned i.e., Khanaspur soil was having most limited soil moisture while in the soil samples of Dunga Galli-a area, the highest values were recorded (Table 4). The results of the particle size analysis of all the stands were almost similar and sand was the dominant fraction observed as nearly all soil samples were sandy to loamy sand except Dunga Galli (a) site where loamy soil exists.

The data obtained after VAM assessment of both the plant species showed that *Urtica dioica* is comparatively less mycorrhizal than *Rumex nepalensis*. All three types of infection i.e., vesicular, arbuscular and hyphal were higher in *Rumex nepalensis*. Vesicular infection in *Rumex nepalensis* was significantly higher in stand 1 and 2. However, in rest of the stands there was no significant difference in vesicular infection between both the plant species. The arbuscular infection on the other hand was significantly different in stands 1, 2 and 6 while stands 1, 2, 7 and 8 indicated significant difference in hyphal infection for both the plant species (Table 6).

DISCUSSION

The reason that certain species grow together in a particular environment is usually because they have similar requirement for existence in terms of environmental factors such as light, temperature, water and soil nutrients and drainage etc. They may also share the ability to tolerate the activities of animals and humans such as grazing, burning, cutting or trampling[10]. Present study points it out that *Urtica dioica* and *Rumex nepalensis* share the same ecological amplitude and are exploiting the similar resources available in different stands. This growing together of plant species in a particular location shows a definite association or affinity with each other. The idea of association is very important and implies that certain species are found growing together in certain locations and environment more frequently in the season than would be expected by chance. In this paper, the detailed list of floristic composition is not given to avoid excess details yet we observed that apart from *Urtica* and *Rumex* communities, other plant communities were restricted to specific spatial area.

As the study area was divided into Murree Hills and adjoining Galliyats and the stands of Galliyats that comprised of Dunga Galli, Ayubia, Murree Pipe Line and Khanaspur were almost located at the same altitude ranging from 2030 to 2160 m. They showed almost same physical and chemical characteristics of soil. Some other soil characters of stands such as deleterious effects and coarse skeletons were more or less the same. Furthermore, the similar type of data was collected for these parameters from Murree Hills stands.

In the stands 1 and 2 i.e., Dunga Galli (a) and (b) the dominant species observed while computing the importance value, were *Urtica dioica* and *Rumex nepalensis*. The total percentage area covered by all species in these stands 1 and 2 in autumn was less than that recorded in spring season (Table 4) and thus constituted the highest importance value in all the stands (Table 2). This high importance value was due to high values of relative density and relative cover. In the spring season the importance values of both species were reversed which was, however, due to high values of relative density and relative cover. The cover expresses indirectly the biological activity of species in regards to utilization of environmental resources[11]. Both the stands have high percentage of organic matter and nitrogen. Because of high contents of organic matter these stands were found species rich. The amount of various mineral ions present showed a great difference. The amount of potassium and magnesium shows a low value, whereas calcium showed high value. Calcium when present in adequate quantity imparts physical and chemical stability to the whole soil complex, aggregating the fine colloidal particles into aggregates thus giving a granular structure to the soils and fine clays, which without calcium are unfavorable to many life forms[12]. Many workers correlated the favorable soil structure due to enhanced calcium in soil and presence of plant cover as a factor[13,14] plus soil capable of manifesting resilience to stresses like erosion and deleterious effects[15].

The soil nutrient status and mycorrhizal fungi influence plant community dynamics. Many workers have emphasized the role of mycorrhizal fungi in modifying plant community features. The current study uncoupled the effects of phosphorus, organic matter and mycorrhizas on plant colonization and indicated that these three

Table 5: Physical and chemical parameters of soil

Stand's	pH	Organic matter (%)	Moisture (%)	Clay (%)	Silt (%)	Sand (%)	Textural Class	Nitrogen (%) N	PO^{-}_{4} (ppm)	K^{+} (ppm)	Ca^{++} (ppm)	Mg^{++} (ppm)
Dunga Galli(a)	6.85	7.83*	2.40*	20	28	52	LOAMY	0.184*	0.01*	2.58	119.80	2.54
Dunga Galli (b)	6.90	7.43	1.36	18	29	53	SANDY LOAM	0.179	0.01*	2.49	118.76	2.31
Ayubia	6.80	6.83	1.99	12	25	63	SANDY LOAM	0.112	0.16	2.24	108.56	2.04
Murree Pipe line	6.85	5.84	1.04	16	22	62	SANDY LOAM	0.123	0.28	2.31	107.79	1.98
Khanaspur	6.94	3.07**	0.34**	4	12	84	SANDY LOAM	0.110	0.47**	2.29	105.84	2.39
Lower Topa	6.85	3.88	0.67	3	19	79	LOAMY SAND	0.072	0.14	2.56	98.56	1.94
Kuldana	6.84	3.56	1.49	13	20	67	SANDY LOAM	0.067	0.24	2.51	94.32	1.75
Lawrence College Road	6.90	5.15	1.68	11	11	78	LOAMY SAND	0.056**	0.33	2.42	96.54	1.86

* Highest value ** Lowest value

Table 6 : Percentage infection of VAM fungi in the roots of *Urtica dioica* and *Rumex nepalensis* collected from different stands

	Rumex nepalensis			Urtica dioica		
Stands	Ves	Arb	Hyp	Ves	Arb	Hyp
Dunga Galli (a)	10^{a}	6^{a}	35^{a}	6^{b}	3^{b}	20^{b}
Dunga Galli (b)	13^{a}	7^{a}	33^{a}	7^{b}	2^{b}	19^{b}
Ayubia	9^{a}	4^{a}	30^{a}	10^{a}	3^{a}	21^{a}
Murree Pipe line	15^{a}	5^{a}	29^{a}	15^{a}	4^{a}	23^{a}
Khanaspur	17^{a}	6^{a}	29^{a}	14^{a}	4^{a}	27^{a}
Lower Topa	18^{a}	6^{a}	31^{a}	14^{a}	3^{b}	30^{a}
Kuldana	19^{a}	5^{a}	41^{a}	15^{a}	4^{a}	29^{b}
Lawrence College Road	17^{a}	4^{a}	39^{a}	16^{a}	4^{a}	28^{b}

Values in a line followed by a different letter(s) for same parameter shows significant difference ($P < 0.05$)
Ves. = vesicles, Arb. = arbuscules, Hyp. = Hyphal

factors favored the growth of *Rumex*, a late successional herb, over *Urtica dioica* species. As far as the role of mycorrhizae in structuring plant communities[16] is concerned, present findings are very significant because it supports the hypothesis that VAM root colonization is prevalent in phosphorus deficient situations as in the case of Dunga Galli stands where least soil phosphorus contents were recorded while maximum arbuscular infection in *Rumex nepalensis* was analyzed. Presence of arbuscules indicates metabolic activity that exchange between plant and fungi is taking place and mycorrhiza is active[17]. Thus dominance of *Rumex nepalensis* is a sign that it is more appropriately adapted in utilizing the symbiotic association.

The reason why *Urtica dioica* poorly formed arbuscular infection in all the stands can be explained on the basis of non-healthy symbiosis. Many workers have documented that after entering the root cortical cells the mycorrhizal fungi causes necrosis and seedling mortality[18]. Several root pieces of *Urtica dioica* during VAM study were found to have necrotic structures on its surface that testifies the non-healthy symbiosis. This might be the most plausible explanation of less dominance and comparably low importance value of *Urtica dioica* in all the stands than *Rumex nepalensis*. The feature that is highlighted from present study reveals that mycorrhizae-compatible species can maintain themselves in more stable fashion, which could lead to the establishment of dominant plant community.

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