

Effect of soil moisture on composition and diversity of trees in tropical dry forest

Abstract

The rainfall gradients and the availability of soil water are highly associated with the distribution, diversity and primary productivity of plant communities. Studies have also indicated the association of drought with increased mortality and decreased growth rates in tropical plants. Here we are presenting some results from our study in tropical dry forests of India where we have observed the influence of soil moisture content (SMC) on composition and diversity of trees in the forest region. The research was conducted in a mature, naturally established and unmanaged tropical dry forest. In our study, Shannon-Wiener index, Whittaker's index of species evenness and Margalef's index of species richness of the trees in the three growth stages (i.e., adult, saplings and seedlings) exhibited significant positive relationships with SMC. We suggest that the climate change led alterations in environmental conditions may become lethal to a large number of established species, which could immediately be replaced by the immigrants. Therefore, the species response to variations in SMC should be properly investigated while designing the reforestation programs for the tropical dry forest.

Keywords: soil moisture content, tropical dry forest, species composition, species diversity

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Introduction

The distribution, diversity and primary productivity of plant communities have been reported to be highly associated with rainfall gradients and the availability of soil moisture.¹⁻¹² According to the theory of non-equilibrium ecology, the soil water availability is the most important factor in system dynamics.¹³ Along with tropical dry forests, the rainfall conditions have also been observed to influence the distribution and diversity of plants in the moist and wet tropics,¹⁴⁻¹⁷ therefore soil moisture availability could be one of the main factors, affecting habitat associations of tropical trees, shrubs and herbs.¹⁸⁻²¹ Studies have also indicated the association of drought with increased mortality and decreased growth rates in tropical plants.²²⁻²⁸ These studies have also suggested that the differences for drought resistance among species might be a major factor affecting composition and diversity of plant species in the dry tropics. Variation in SMC leads to changes in the structure and function of the forest ecosystems. These changes could favor few species to establish and also could become responsible for the removal of some species. If the changes in environmental conditions are very high, it may become lethal to a large number of established species, which could immediately be replaced by the immigrants.²⁹ Together with low SMC, disturbance such as cattle browsing and harvesting usually leads to an immediate decline in biodiversity and the process of regeneration.²⁶⁻²⁸ Therefore, the species composition of a forest experiencing disturbance will be a cumulative outcome of differential responses of species to disturbance. Few species could tolerate the disturbance while others may disappear. Here we are presenting some important results from our study in tropical dry forests of India. The research was conducted in a mature, naturally established and unmanaged tropical dry forest (24° 18' 07" N and 83° 05' 57" E to 25° 00' 17" N and 82° 37' 38" E). Results from the study showed the significance of soil depth and soil physical and chemical properties which are directly linked with soil moisture content (SMC) in influencing the plant diversity of the

dry deciduous forest located in Vindhyan highlands, India. Our study reported decline in the number of species with decreasing SMC. In our study, it was also observed that among the dominant or codominant tree species, *Acacia catechu*, *Hardwickia binata*, *Lagerstroemia parviflora*, *Lannea coromandelica* and *Zizyphus glaberrima* increased in importance value with increasing level of soil moisture stress, suggesting that their ability to tolerate drought was higher than that of the other species in the community. In our study, Shannon-Wiener index, Whittaker's index of species evenness and Margalef's index of species richness of the trees in the three growth stages (i.e., adult, saplings and seedlings) exhibited significant positive relationships with SMC (Figure 1). Among the three growth stages, the variability in SMC explained 65% (in saplings) to 77% (in adults) variability in Shannon-Wiener index, 60% (in adults) to 68% (in saplings) variability in Whittaker's evenness index and 39% (in saplings) to 61% (in seedlings) variability in Margalef's richness index. Slope of relationships between soil moisture content and diversity indices had given maximum slope for seedling species as compared to adults and saplings showing greater effect of soil moisture content on the diversity of seedling species.

Conclusion

The study indicates that tropical dry forests contain considerable plant diversity which are highly influenced by soil moisture conditions. Due to the effects of climate change, the variation in SMC leads to changes in the structure and function of the forest ecosystems. These changes could favor few species to establish and also could become responsible for the removal of some species. If the changes in environmental conditions are very high, it may become lethal to a large number of established species, which could immediately be replaced by the immigrants. Therefore, the species response to variations in SMC should be properly investigated while designing the reforestation programs for the tropical dry forest.

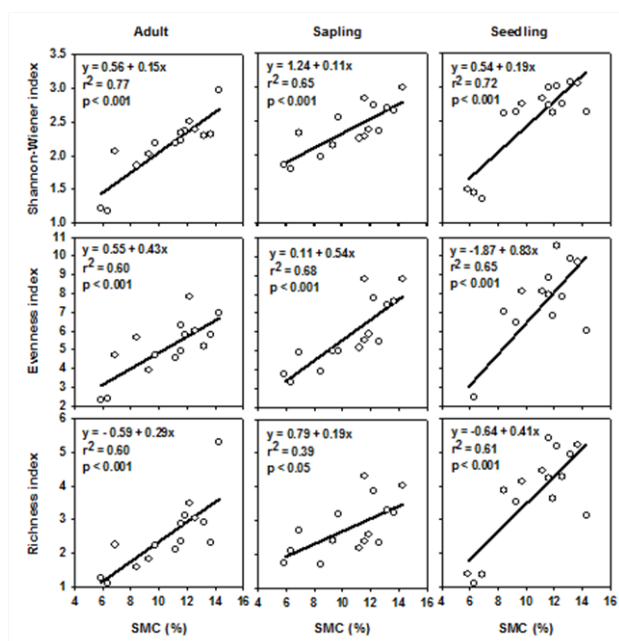


Figure 1 Effect of soil moisture content on Shannon-Wiener index, Whittaker evenness index and Margalef richness index of adult, sapling and seedling species in the forest of Vindhyan highlands (Source: Chaturvedi 2010).

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Conflicts of interest

None.

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