

Mystery of Coexistence and Adaptation of Trees in a Forest Ecosystem

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In a forest ecosystem trees and shrubs along with the associated vegetation grow together mutually. The mystery of coexistence and adaptation of various tree species growing together and capture solar radiation for plant productivity in an ecosystem is not yet fully known. Let us have a conceptual outlook of this ecosystem. The existence of biodiversity of morpho-physiological and biochemical traits of various species help in co-existence and adaptation in a forest ecosystem, thereby each species perform its function without competition with other species, both in the underground and above ground level [1]. Very little is known on the root system diversity in underground soil horizons. The various species coexist but show great diversity to build up a balanced ecosystem without little completion among species for the capture of bio resource for their growth and productivity. There exists great diversity among species in their morpho-anatomical and ecophysiological traits necessary to coexist and adapt themselves in their respective environmental conditions. The physiological requirements for the growth and development of each species differ widely among other coexisting species. In this respect we undertook various studies in Forest Science Faculty of Universidad de Nuevo Leon, Mexico, on the variability in woody plants in their morpho-physiological traits of woody plant species in semiarid regions of Northeast Mexico with an objective to study the biology of woody plants and to understand their possible roles of coexistence and adaptation. Taking into consideration of general aspects of plant, soil climate of the region, we determine a large variability in plant traits such leaf traits, plant characteristics, tree crown architect tur, branching pattern and branching density, leaf surface anatomy, venation pattern and various ecophysiological traits such as phenology, variation in leaf growth parameters, pigments, leaf nutrients, leaf epicuticular wax, water relation, carbon sequestration, litter fall. Let us contemplate how these traits help the species to coexist and adapt themselves in their adaptation to the semiarid environment. In the following we want to mention possible roles of few of these traits in these aspects.

Leaf traits

The variability in leaf traits such as leaf area, size, petiole length, leaf specific weight help in coexistence of various species in theory respective niches as well as in the capture of solar radiation for photosynthesis and plant productivity. We observed seasonal variations in leaf trait for adaptation to particular seasons.

Tree species with open canopy (all leaves exposed to solar radiation) is considered to be more productive compared to those with close canopy (work is in progress). It is postulated that the species with open leaf canopy have high photosynthetic capacity compared to those with open leaf canopy.

It is observed that the species with open canopy in general have high wood density compared to those with close canopy which needs to be confirmed.

Plant characteristics

The variability in plant height, basal diameter, branching pattern of different species help in coexistence and adaptation in the ecosystem.

Characterization of wood fibres of some woody species has been undertaken in relation to their possible utility in wood and paper industry.

Exist a large variability in wood density and wood fibre characteristics which could be related to wood quality and its utilization in wood and paper industry.

Variation in tree crown and branching habit help in coexistence, capture of solar radiation and final productivity, we classified woody plants on the basis of their crown architecture.

There exist great variation in branching pattern and branching density for co-adaption and capture of solar radiation in the forest ecosystem.

Leaf anatomy

Variation in stomata frequency, size help in transpiration, gas exchanges as well as adaptation to environments viz semiarid or humid. In semiarid regions many species show the absence of stomata or its low frequency on the upper leaf surface to avoid loss in transpiration.

Venation pattern determines the capacity of transport as well as mechanical support to the leaf lamina. Variation in venation pattern and intensity help in imparting mechanical strength to the leaf lamina and transfer of photosynthesis and nutrients. Species have been classified on the venation pattern.

Wood anatomy

There exist great variability in wood anatomical structure which could be related to wood quality and their utilization.

Phenology

Variation in flowering, fruiting and seed dispersal maintains rejuvenation of the species in the ecosystem. Different species complete their life cycles in different times of the season for their efficient regeneration.

In addition to various morpho-anatomical traits of the woody species, there exist great variations in ecophysiological and biochemical

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traits helping the species for their co-existence, adaptations, thereby performing their physiological functions [2].

Variation in plant pigments as such as chlorophyll a, b and carotenoids among species demonstrate photosynthetic capacity with respect to the capture of solar radiation.

Variation in leaf nutrients such as macro- and micronutrients, protein, carbon determine its contribution to the growth and development of the species and also providing nutrition to grazing animals in the ecosystem.

Variability in leaf epicuticular wax could determine its capacity of reflectance of incoming solar radiation, thereby reducing transpiration loss and drought resistance.

Variability in water potential among species represents water relation and adaptation to the environment.

Variation in carbon fixation, carbon sequestration determines the storage of energy as carbon store in the biomass and wood among species, it also determines the capacity of the species to reduce carbon load from the atmosphere. We selected species with high carbon sequestration capacity ranging from 48 to 51 percent. These could be recommended to plant in carbon polluted areas to reduce carbon load.

However, all these conceptual hypotheses need to be confirmed in future research.

Cold tolerance

The species show variability in cold tolerance in winter. Some species are tolerant to cold temperature.

We have made charts for various morphological, anatomical and ecophysiological traits for more than 30 woody species in Northeast Mexico for the first time in semiarid environments.

General comments

In the context of our studies on morpho-physiological traits of woody plants (more than 30 species). It is evident to conclude the species show large variability in various traits such as leaf traits, venation pattern, leaf crown architecture, branching density, wood structures, wood density, and several ecophysiological traits such as,

pigment contents, leaf nutrients, carbon fixation, protein contents, leaf epicuticular wax and cold tolerance. This gives opportunity to select particular species for particular morphological or physiological traits for its efficiency in productivity and adaptive capacity in the environment. For example variability in leaf traits could be related to their efficiency in photosynthetic capacity as well as for their coexistence in the ecosystem. The variability in leaf surface components such as pubescence, trichome density, silica could contribute to drought resistance and insect resistance of the species. Variation in venation pattern and venation density could determine the mechanical strength as well as conductive capacity of photosynthesis and nutrients to leaf tissue. This also could be related to the coexistence and adaptive capacity of the species to the prevailing environment.

The species with high pigment contents could be efficient in photosynthetic capacity and productivity which vary in seasons. Variations in leaf micro-and macronutrients could be related to the growth and development and nutritive values for grazing ruminants. This is also dependent on litter fall and its nutrient contents. This in turn could be related to their adaptive values in the environments. The large variability in epicuticular waxes on leaf surface could be related to the variability in the reflection of light thereby imparting lower temperature and better adaptation in the semiarid drought environment. Carbon is the source of energy stored in timber and biomass. Large variability exists among species for carbon sequestration which help in reduce carbon pollution as well the productivity of trees. The species with high carbon fixation could be planted in carbon polluted areas. There exists variability in sensitivity to low temperature among the species in winter season. In fact different species has inherent capacity to capture bio resource and environments for maintaining their physiological function and productivity. This information will unveil the mystery of adaptation to the environments in the ecosystem, there is a great necessity of concerted research on these multi-prone aspects to unveil the mystery of adaptation and protect and efficient management our forest treasure.

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