EDITORIAL

COLUMN

Variability in Leaf Canopy Architecture may be Related to Photosynthetic Efficiency and Carbon Fixation

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Leaves contribute greatly in plant growth and productivity for photosynthesis and nutrient contents. Thereexists a great diversity among plant species in growth form, leaf size and shape and canopy management. In addition, there exist some general relations across a wide range of species in leaf traits with respect to carbon fixation between species. The outer canopy leaves and its specific leaf area (SLA, leaf area per unit mass) tends to be correlated with leaf nitrogen per unit dry mass, photosynthesis and dark respiration sites (Wright et al., 2001). The availability of nutrients in leaves is essential for efficient plant function. Besides, a large variation among species with traits favours nutrient conservation. The importance of leaf nutrient content in plant function is well documented with respect to nutrient conservation, life span, high leaf mass per area, low nutrient concentration and low photosynthetic capacity (Reich et al., 1997).Sufficient research activities have been undertaken on nutrient content and metabolism in leaves. Leaf nutrient content depends on the availability of nutrients present in the soil media (Chapman, 1990;Grime 1999). Within a given habitat, species with a range of leaf traits can coexist (Reich et al. 1999). The readers may consult various studies with respect to plant nutrients (Negi and Singh, 1993; Ackerly and Bizzaz, 1995;Aerts, 1996; Hikosaka, 1996;Nooden, 1988).

In our preliminary studies, we observed large variability in the contents of macro- and micronutrients in native woody species of the semiarid regions of northeaster Mexico.In our survey, both in Tamaulipanthornscrub of semiarid Mexico as well as in our recent visits to rainforests of southern Mexico, we observed that there exists a great variability in leaf canopy with respect to open canopy, semi-close and closed canopy associated with variations in leaf size, shape, and leaf surface structure. Species can be classified on the basis of this important trait.The hypothesis is that tree species with open canopy have a high capacity in the capture of solar radiation for the photosyntheticprocess; thereby, high carbon sequestration is expected compared to those with close canopies. We also observed that the tree species with open canopy produces highly branched and thin stems compared to those with close canopy which produces a thick basal stem area with thick primary branches. We went further to confirm our hypothesisby taking more quantitative data yet to be analysed.In our recent study, we estimated the contents of macro- (Ca, K, Mg, K, N, and P) and micro-nutrients(Cu, Fe, Mn, and Zn) of ten native shrubs and trees of semiarid Mexico. We observed large variability in nutrient contents among species.We also observeda large variability in carbon content. We selected four species which contained high carbon concentration, about 50% viz; the mean value of C content (sequestration) ranged from 37% to 50%. The species withcarbon content close to 50% were:*Leucophyllumfrutescens*, *Forestieraangustifolia*, *Bumeliacelestruna*, and *Acacia berlandieri*. These species may be recommended for reforestationpurposes. Interestingly, we observed that these four species possess open canopy architecture revealing that theshrub species have a high capacity to capture solar radiation for the efficient production of photosynthates and high carbon fixation. Further studies are in process on the quantification of plant traits and its relation to plant productivity. This could be a promising line of research in the field of forest science.

To further test our hypothesis based on our results and understanding of the relevant literature, we concluded that our hypothesis should be that photosynthetic efficiency and carbon fixation are related to leaf canopy architecture.In order that we fully address this question, differences in the ecology of individual species and different kinds of plant communities that may occur must be evaluated. For this reason, we propose three types of plant communities.These may benative multi-species natural or semi-natural vegetation, monospecific plantations (monoculture) of a given species, and planted mixtures of some form of sets of species. This division is expected to encompass all potential variability with respect to factors such as allelopathic effects and individual habitat species preferences as well as biomass gain and canopy architecture resulting from genetic variability not only within species but also the performance of individuals with respect to habitat differentiation.

For the majority of the species,surveys from field measurements or sample plots will provide almost certainly an inadequate number for species level analysis as it is most common in tropical and subtropical plant communities to have very low dominance of individual species on a per hectare basis with consequently very large number of them. Therefore, different species will have to be clustered(aggregated in ecological groups for the purposes of the analysis).This grouping will be related to two kinds of variables.The first is canopy architecture while the second will be biomass growth rate and more specifically diameter growth rate. The second abovementioned characteristic is related to both photosynthetic efficiency and carbon sequestration because of its ability to promote growth of woody perennials as a fundamental growth index as has been proven worldwide by a variety of studies. It also provides a cheap and reliable index in relation other measures like canopy biomass gain because it has been shown to be correlated well with these and provide a simple and viable alternative to destructive sampling techniques.A priori and a posteriori grouping of species are both perfectly acceptable methodologies to cluster species and with respect to this non continuous variables for a given trait such as type of canopy architecture or mean leaf size in maturity, are perfectly acceptable.

The sampling scheme and grouping methodology described above will also take under consideration the significant differences in the studied variables with respect to the stage in the life cycle of a given species. Studies have shown this to differentiate and it is interesting to conduct separate analyses of this to determine more specific differences, if the finalized datasets are adequate for purposes of statistical analysis.

Ideally, there will also be a wide range of habitat disturbance classes also measured. This will include former agricultural land use that is now abandoned among other kinds of habitats. This is because in certain studies of this kind using data from undisturbed vegetation only statistical relationships proved weak while in others that included disturbed vegetation results were more statistically significant, possible because of greater differentiation between fields due to the greater spectrum of habitat conditions. Studies which include both disturbed and undisturbed ecosystems have this. For the Tamaulipanthornscrub ecosystem in the northeastern region of Mexico,the desire to address such issues is very relevant because of the endangered status of the ecosystem warranting immediate action to be taken towards devising schemes for sustainable management, conservation and restoration of this habitat; such relationships need to be known and quantified with a very high level of precision. This type of research will also assist relevant work elsewhere by enriching the necessary knowledge base.Care must be taken in conducting such measurements in the field as the relative health of individual specimens of a given species may vary significantly and care must be taken to measure only healthy or relatively healthy individuals using some form of canopy health status score.

Inter-institutional collaboration will be essential in addressing this hypothesis not only for collecting data but also for issues related to arriving at the most parsimonious working model for testing the scientific hypothesis.