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Leaf Coloration during Autumn: A Purpose to Survive

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The leaf coloration during autumn, a recondite subject till today, needs to be expounded. The coloration is usually linked to leaf fall. The vastnessof the event as evident from images obtained through satellite becomes compelling to understand its purpose and mechanism. While its link to leaf senescence has been ascertained, the involvement of genetic control cannot be ignored. Recent analyses show that a limited number of plant species exhibit autumn coloration could be due to unmasking of carotenoids (CAR) in the chloroplast as result of senescence mediated chlorophyll break down and/or increase in anthocyanins level.

Leaves in general are green due to the presence of Chl in chloroplast in a dominant proportion. Leaf senescence is characterized by decline in photosynthetic activities and degradation of Chl and proteins. Remobilization of nitrogen from senescing leaves to young tissues is the main function that holds-up leaf fall (known as competition hypothesis). Chl are broken down into colourless metabolites in course of senescence and the leaves are turned into yellow revealing the colour of carotenoids those are otherwise present in the chloroplasts. Plants develop several mechanisms to prevent photodamage by either controlling the absorption of light energy, diverting the absorbed light from being used for photochemistry or both. In the process some red-shifted Car and red-shifted Chl are delinked from the core complex and localized adjacent to plasma membrane leading to red coloration. The de novo synthesis of anthocyanin concomitant with chlorophyll degradation results in red coloration of leaves during senescence in some plants species. The coloration, however, depends on the level ofChl (purple with higher Chl concentration) and p^H of vacuoles (basic: blue; acidic: red).

Both Car and anthocyanin have been implicated in photo protection against the damaging effect of reactive oxygen species (ROS) generated within chloroplast. Car, an essential components of light harvesting chlorophyll protein complex (LHCP), besides transferring its absorbed energy through singlet–singlet transfer mechanism for light harvesting process, quenches the triplet state of Chl a through triplet-triplet energy transfer mechanism. These pigments are relatively stable during leaf senescence and even are synthesized during ripening of colourful fruits, a strategy to save from the onslaught of ROS. Anthocyanins, on the other hand, screen outharmful photon of solar spectrum to reach chloroplaststo save the organelle from photodamage. They are known toneutralise H_2O_2, a potential ROS formed in the chloroplasts and penetrates into vacuole, the site of accumulation of anthocyanins.

Anthocyanins by slowing down the formation of abscission layer of the leaf, provides ample time for relocation of nitrogen to young tissues of the plant. Even during developmental phase in some nitrogen deficit plant, there is intense red colouration due to higher level of the pigment that helps in nitrogen translocation. On the other hand plants with N-fixing actinomycete bacteria, where leaf nitrogen resorb is redundant, the abscission of leavestakes place while green.

Another hypothesis (coevolution hypothesis) with strong genetic basis veers round the defense mechanism adapted by leaf against biotic stress. The fiery colorations of leaf distract the insect from laying down their eggs on the surface of leaves and save the leaves from being spoiled. However, a big question arises why then many other plants don't adapt to this mechanism?

Autumn coloration in general and leaf yellowing in particular need an in depth study. Leaf coloration has adaptive values against environmental stresses and animal-plant interactions. Another aspect that needs to be developed is the measurement of change in entropy and enthalpy of the system during leaf senescence that may provide enormous insight in to the subject of leaf coloration.

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