INTRODUCTION
CHAPTER 1

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Plant development is a complex process which basically comprises cell division, cell differentiation and growth. Unlike animals, where development is highly controlled and exactly specified, plant development and organization is extraordinarily plastic. Plant development is continuous and indeterminate since growth and differentiation are localized throughout the plant body at meristematic zones (Steeves and Sussex, 1989). The appearance of new organs such as leaves or flowers results from organized cell division and differentiation in these meristems (Medford, 1992). During the course of cell division in apical meristems, the organ primordias are initiated continually, constituting of a large number of cells, which act in synchrony to follow a programmed sequence of division, expansion and differentiation to form a determinate appendage such as the leaf. In most cases once an organ is differentiated and cell expansion is completed, it does not grow further, and performs its function till the onset of senescence. In this respect, monocot leaf development differs from development in other organs, as the monocot leaf is under a continuous state of differentiation, as it possesses a basal meristem which continuously contributes new cells at the leaf base.

Though the process of leaf initiation and development is genetically determined, the acquisition of a photoautotrophic mode of nutrition in the leaf is solely dependent on availability of an environmental factor-light. In the
absence of light, leaf development follows a strategy called **scotomorphogenesis** wherein leaves are yellow in color due to absence of chloroplasts, and plastid differentiates to etioplast. In the presence of light, a normal photomorphogenic development is initiated wherein the leaf develops normal chloroplasts. In higher plants, greening of leaves involves a series of distinct morphological and biochemical processes leading to differentiation of cells and organelles such as chloroplasts. Chloroplast development requires a complex interaction between nuclear and plastid genomes which is triggered by light and a chloroplast-derived plastidic signal. In addition, light is also required for photoreduction of protochlorophyllide to chlorophyll (Hoober, 1984). In C₄ plants leaf development is further accompanied by differentiation of two photosynthetic cell types viz., bundle sheath and mesophyll cells. The photosynthetic reactions are split between these two cell types with each cell type accumulating a specific complement of **photosynthetic** enzymes (Langdale and Nelson, 1991).

Leaves are the principal site of photosynthetic carbon fixation, depositing excess of fixed carbon in the chloroplast in the form of polymeric carbohydrates like starch, which is subsequently degraded and mobilized to different parts of the organism. The starch deposited in chloroplasts is mobilized via the action of starch degrading enzymes like amylases and phosphorylases. While there have been a number of investigations outlining photoinduced leaf development and chloroplast biogenesis in relation to synthesis of enzymes and proteins involved in trapping of light energy, carbon fixation and generating sugars etc., the development, extent and role of starch degrading enzymes during leaf development is poorly understood. Most
importantly, little is known about the influence of cellular position on development of these enzymes.

The monocot leaf offers an ideal system to study the interrelationship between cell development and intercellular regulation of cytosolic and plastidic enzymes. The monocot leaf lends itself best to study different developmental stages along the leaf axis, as it possesses a continuous gradient of maturing cells from the base to tip of the leaf. Moreover, parallel to the cell-differentiation gradient, a gradient of chloroplasts in different developmental states also exists from the base to the tip of these leaves. In the present study the relationship between leaf development and starch degrading enzymes was studied by using the leaves of monocotyledon plant, pearl millet (*Pennisetum americanum*). Being a C₄ plant, the pearl millet also possesses dimorphic chloroplasts. The studies were directed towards deciphering the interrelationships between cellular position, gradient of cell maturation, chloroplast differentiation and photoregulation of starch degrading enzymes, viz., amylases and phosphorylases. The possible role of these enzymes in mobilization of photosynthetically generated transitory starch was also examined.