Chloroplast activity and cellular energy state under low temperature stress

by

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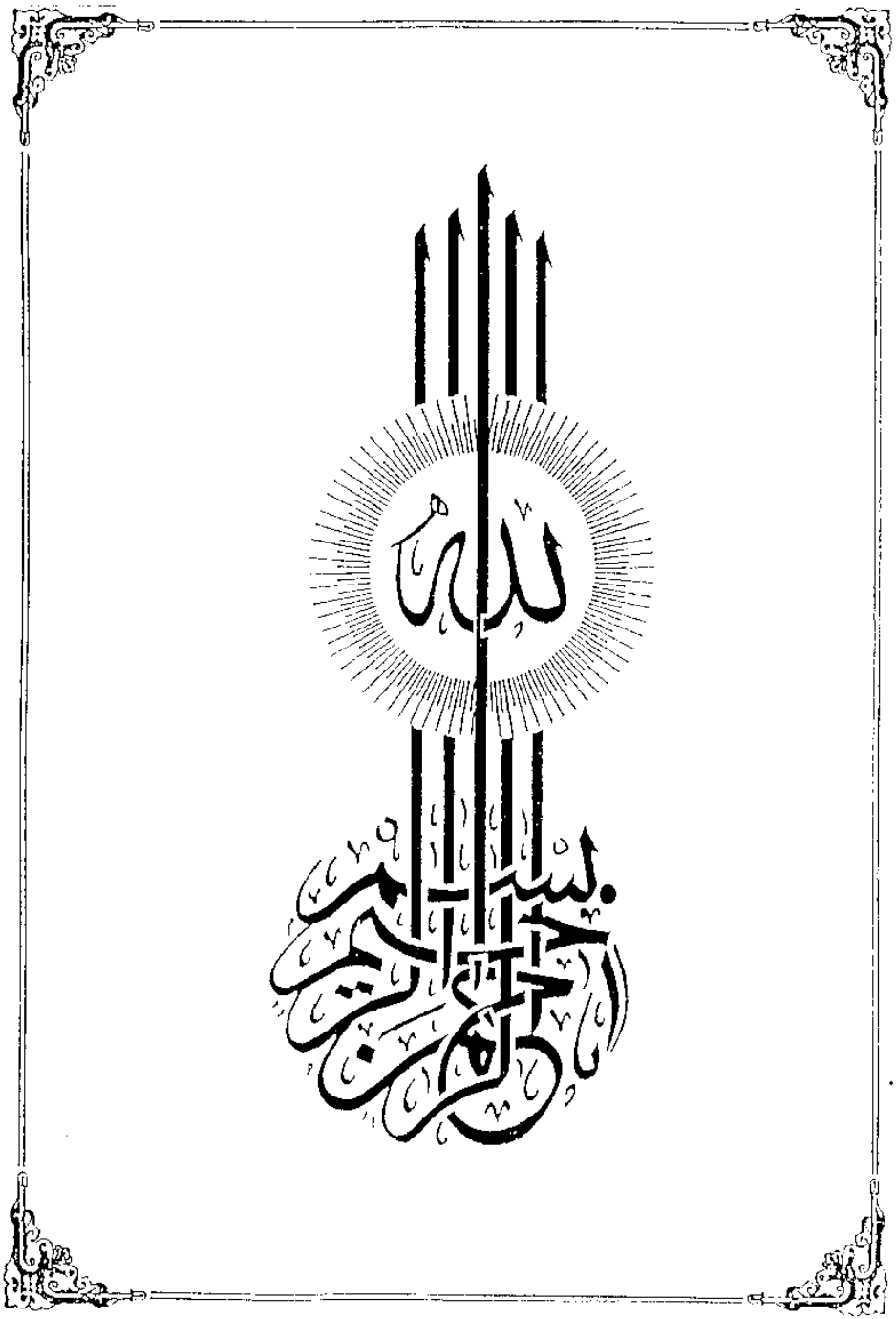

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Introduction

The effects of low temperature , in the natural environment are divers , and complex , and have been studied by most biologists at many levels . Reduced temperature and its effects on productivity and survival of plants is specially an area of major concern , particularly where food crops are involved . In the laboratory the influence of low temperature have been studied through to the cellular and molecular levels to give insight into basic biological mechanisms , and a more complete understanding of the effects of reduced temperatures on biological systems .

Generally , The study of the plant capacity to acclimate to any particular stress under controlled enviromental conditions usually involves a comparison of a physiological and molecular changes that occure as a consequence of shifting plants from some optimal controlled growth regime to another suboptimal regime for a predetermined period of time .

During cooling or freezing of biological system , the cold environment acts as a heat sink which absorbs the thermal energy given off by the biomaterial until that material is in equilibrium with the surroundings . The major effect of reduced temperature on any system is the reduction of molecular motion which , for biological systems , has important consequences on chemical and physical processes , including the biochemical reactions of living tissue. Furthermore , cooling below $0^{o}C$ bring about dramatic changes in biological systems , especially if the water in the intra- and extra- cellular solution freezes and separates as ice , giving rise to physico-chemical changes which may be lethal to cells . Nevertheless , observation and studies on large variety of biological sample show that biological system either withstands decrease in temperature (resistant) or succumbs to injury (sensitive) . Chilling-sensitive plants , such as tomato (*Lycopersicon esculentum*) , show sign of injury when exposed to temperature above the freezing point of tissue up to approximately 15 ^{o}C *(Wilson 1987)*

Chilling injuries are complex Physiological disorder and there is no reason to assume that the same sequence of events leads to injury in species of tropical or subtropical origin . The most important effect of lowered temperature may be on the fluidity of the membrane lipids , but in other species , the primary effects may be on the non-membrane proteins , cytoskeleton or cytoplasm . A large number of changes or primary events are therefore possible during chilling , and it is these changes which eventually caused injuries such as imbalance in metabolism , ion leakage or membrane breakdown which may ultimately result in cell death.Development of injury depends on the temperature , growth conditions , period to chilling , the age of plant , light intensity , relative humidity during chilling , and rate of cooling and rewarming .*(Wilson 1987)* . However the exact mechanism of cryoprotection or cryoinjury at the molecular level is not yet fully understood.

Since chloroplasts are among the major site of injury following exposure to low temperatures , the present study was undertaken to compare chloroplast activity in the chilling -sensitive plants (tomato , *Lycopersicon esculentum* , var. koshirock) , and chilling - resistant plants (spinach , *Spinacea oleracea*) to obtain some information underlying the mechanism of cryoinjury and cryoprotection at molecular level . accordingly the present study , included investigation of the thermal behavior of some photosynthetic reactions of chloroplast isolated from both chilling - sensitive and chilling - resistant plants , and also to investigate the effect of chilling stress on the chloroplast activity , plant pigments , ion leakage , and fatty acid composition of leaf lipid using the different plants , chilling sensitive and chilling - resistant species.