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Differential tolerance toward oxidative stress between immature and mature leafy spurge leaves – An evolutionary mechanism for survival under adverse environmental conditions?

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The most effective method for controlling leafy spurge is to kill the crown and root buds or to break bud dormancy and kill the newly emerging shoots. However, crown and root buds did not break dormancy and emerge unless the entire shoot or above-ground portion of the plant was excised or killed with 2,4-D. The apical leaves are able to survive severe conditions such as moisture stress, pathogen invasion (mildew), herbicide (diclofop-methyl), etc., whereas more mature leaves were killed rapidly and abscised. The various dissimilar stresses mentioned above are known to have a common lethal mechanism, i.e. the induction of active oxygen species (AOS)(free radicals) to cause rapid cell destruction and death. A consequence of AOS formation is the secondary induction of ethylene which is not the lethal factor. Diclofop-methyl (DM) was used as a physiological probe to induce oxidative stress on leafy spurge. Significant increases in ethylene was induced by DM and 2,4-D over control tissues in mature and immature leafy spurge leaves. However, only mature leaves were killed by DM whereas all leaves were killed by 2,4-D. AVG (aminoethoxyvinyl-glycine) inhibited completely ethylene induction by both 2,4-D and DM. Conversely, vitamin E (tocopherol) inhibited DM induction of ethylene by approximately 50% of control but it had no effect on ethylene induction by 2,4-D. Therefore, the action of the inhibitors on ethylene production indicates that DM induces death of mature tissues by a free radical oxidation mechanism in contrast to 2,4-D which induces ethylene by an alternative mechanism not involving AOS. Tocopherol, an effective scavenger of AOS, protected leafy spurge hypocotyls from damage by DM in tissue culture. It is hypothesized that apical tissues may survive oxidative stress due to more active antioxidation systems than mature tissues and, therefore, prevent root buds from emergence and damage under adverse environmental stress conditions.