OXIDATIVE RESPONSE OF GREEN GRAM SEEDS UNDER SALINITY STRESS

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Green gram (Vigna radiata (L.) Wilczek cv. K 851) seeds given a NaCl salinity stress treatment from the onset of germination showed an increasing oxidative response. An increase in proline content was observed in both root and shoot tissues. With an increase in NaCl concentration, electrolyte leakage and lipid peroxidation increased noticeably in both root and shoot. An uniform increase in total peroxide content was recorded with a concomitant increase in the activity of antioxidative enzymes like catalase, guaiacol peroxidase and superoxide dismutase in both root and shoot tissues under salinity stress.

Key words: Oxidative response, salinity stress, Vigna radiata.

The soil salinity problem is widespread in the arid and semi-arid areas and in the sub-humid and humid climates particularly in the coastal regions where ingress of sea water results in large scale soil and water salinisation. Sodium chloride is by far the most prevalent salt abundant in saline soils. In order to overcome these problems, crops which are resistant to salinity are to be grown. It would therefore, be important to identify the morpho physiological as well as biochemical parameters identifying salinity sensitivity in the crops. Soil salinity decreases the water potential of soil water and reduced water availability to the plants results in imbalance in plant metabolic process (Chazen and Neumann 1994). NaCl stress not only affects water status but also affects the mechanical properties of the cell wall (Acevedo et al. 1971). NaCl stress induce reactive oxygen species (ROS) production and leads to oxidative damages. These toxic oxygen species may react with macromolecules, the proteins and lipid components of membrane causing damage through lipid peroxidation, resulting in increased permeability of membrane. Osmoprotectants such as proline are usually accumulated during exposure to salinity stress. These osmoprotectants help the plants to overcome stress condition (McNeil et al. 1999). The objective of the present work is to understand the correlation between membrane damage and accumulation of osmolyte (proline) and the altered activities of antioxidative enzymes in green gram seedlings.

Healthy uniform green gram (Vigna radiata (L.) Wilczek cv. K 851) seeds were surface sterilized with 0.1% mercuric chloride (HgCl₂) for five minutes and thoroughly washed in tap water and rinsed in distilled water. Seeds were germinated in petriplates containing different concentrations (0, 0.25, 0.5%) of NaCl solution and kept in dark for one day at 25±2°C. On the second day petriplates containing germinating seeds were transferred to a growth chamber and the white light was provided by filtered cool, white fluorescent tubes (36W, Philips TLD) with a photon flux density of 52 μmol m⁻² s⁻¹ (PAR). On the 10th day of growth, seedlings were sampled and root and shoot are detached and were taken for various estimation.

For measuring solute leakage, plant parts were kept in petriplates containing distilled water for 24 h in dark and then conductivity of the medium was measured with a conductivity meter. Extraction and estimation of proline was done as per the method of Bates et al. (1973). Tissue (0.5g) was homogenized in 5% TCA and the homogenate was used for the extraction and estimation of total peroxide (Sagisaka 1976) and thiobarbituric acid reactive substances (TBARS) (Heath and Packer 1968). Extraction and assay of catalase (CAT), guaiacol peroxidase (GPx) and superoxide dismutase (SOD) were done as per the method of Chance and Maehly (1955) and Giannopolitis and Ries (1977) respectively.
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Fig. 1 depicts an increase in proline accumulation with an increase in NaCl concentration in the root and shoot. During periods of NaCl stress, proline acts as an osmoprotectant perhaps by interacting with enzymes or may protect proteins and membrane from damage by inactivating hydroxyl radicals (Delauney and Verma 1993, Smirnoff and Colombe 1988). The tissue permeability status measured in terms of electrolyte leakage increased with NaCl concentration both in shoot and root. The maximum increase was in root tissue as reported earlier by Bhattacharjee and Mukherjee (1997). This observation was further supported by a substantial increase in lipid peroxidation measured as TBARS contents suggesting a membrane damage. Salt stress is known to induce oxy-free radicals and this increase in TBARS contents is due to lipid peroxidation by free radicals (Dhindsa et al. 1981, Bhattacharjee and Mukherjee 1997, Shim et al. 1999).

Total peroxide content showed a similar increase with an increase in salinity stress as reported earlier by Bhatacharjee and Mukherjee (1997). The increase in peroxide accumulation was associated with decrease in antioxidative enzymes like catalase (CAT), guaiacol peroxidase (GPX) and superoxide dismutase (SOD) (Fig. 2). This might result in toxic oxy free radicals causing inhibition of seed germination and seedling growth (Zhang and Kirkham 1996, Bhattacharjee and Mukherjee 1997, Saha and Gupta 1997).

Fig. 1. Changes in proline content, electrolyte leakage and thiobarbituric acid reactive substances (TBARS) content in root and shoot tissue of green gram subjected to NaCl-salinity treatment. Vertical bars represent mean data ± SEM. R and S represent root and shoot tissues respectively.

Fig. 2. Changes in total peroxide content, catalase (CAT), guaiacol peroxidase (GPX) and superoxide dismutase (SOD) activities in root and shoot tissue of green gram subjected to NaCl-salinity treatment. Vertical bars represent mean data ± SEM. R and S represent root and shoot tissues respectively.
REFERENCES


