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Changes in oxidative stress defense system in wheat (*Triticum aestivum* L.) and mung bean (*Vigna radiata* L.) cultivars grown with and without mineral nutrients and irradiated by supplemental ultraviolet-B

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Abstract

Field study was conducted to evaluate the inter- and intra-specific variations in sensitivity of two cultivars each of wheat (*Triticum aestivum* L. cv. HD 2329 and HUW 234) and mung bean (*Vigna radiata* L. cv. Malviya Jyoti and Malviya Janpriya) to supplemental levels of UV-B irradiation (sUV-B, 280–315 nm) with and without recommended levels of mineral nutrients. Results showed decrease in photosynthetic pigments and biomass of all the four cultivars due to sUV-B radiation. Antioxidative defense system was activated in all the cultivars after irradiation with sUV-B. SOD, peroxidase and total thiol contents increased, while catalase activity and ascorbic acid contents decreased under sUV-B irradiation. On the basis of biomass, UV-B sensitivity can be arranged in decreasing order as: Malviya Janpriya < Malviya Jyoti < HD 2329 < HUW 234. Application of mineral nutrients (N, P and K) showed significant positive response in all cultivars by ameliorating the negative impact of sUV-B.

Keywords: Ultraviolet-B radiation; Mineral nutrients; Wheat (*Triticum aestivum* L.); Mung bean (*Vigna radiata* L.); Photosynthetic pigments; Antioxidant defense system; Biomass

1. Introduction

Stratospheric O_3 reduction is one of the pressing global concerns of climate change, which has prompted recent efforts in assessing the potential damage to vegetation due to supplemental levels of ultraviolet-B (sUV-B, 280–320 nm) radiation (Caldwell et al., 1998; Hollosy, 2002; Kakani et al., 2003). Numerous studies have investigated the effects of elevated UV-B on plants, and have shown a diverse range of responses, including changes at the physiological, morphological, biochemical and molecular levels (Caldwell et al., 1995; Jordan, 1996; Allen et al., 1998; Paul, 2001).These studies have shown deleterious effects of UV-B such as reduced photosynthesis, biomass reduction, decreased protein synthesis, damage to nucleic acids and lipids (Jordan, 1996; Jansen et al., 1998; Rathore et al., 2003).

Under light conditions, photoreduction of O_2 in green plants is an unavoidable process that can results in superoxide anion ($O_2^{\bullet -}$) production. Dismutation of $O_2^{\bullet -}$ by superoxide dismutase (SOD) results in the formation of oxygen and hydrogen peroxide (H_2O_2) and the latter can react with $O_2^{\bullet -}$ to create the highly reactive hydroxyl radical ($^{\bullet}OH$) via the Haber–Weiss cycle (Bowler et al., 1992). Different species of plants accomplish protection towards stress through different biochemical adjustments but reactive oxygen species (ROS) scavenging is a common response to most stresses. ROS scavenging depends on the detoxification mechanism provided by an integrated system of nonenzymatic reduced molecules like ascorbate and glutathione as well as enzymatic antioxidants like SOD, catalase and peroxidase (Dai

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et al., 1997; Srivalli et al., 2003). At present, our knowledge concerning the role of the antioxidant system in protecting plants under UV-B stress is limited because few studies have been made covering a small number of plant species (Costa et al., 2002; Kakani et al., 2003).

Responses of plants to UV-B vary not only among the species, but also among the cultivars of same species (Tevini, 2000). Variations in responsiveness of different species and cultivars to UV-B were also reported for a variety of plant species (Dai et al., 1994; Smith et al., 2000; Alexieva et al., 2001; Yanqun et al., 2003a,b; Zu et al., 2004). The effects of UV-B on leaves can be mimicked by free radical generators and prevented by antioxidant feeding (Mackerness et al., 1998). Smith et al. (2000) concluded that variations in UV-B sensitivity between different species represent the relative contribution of morphological, physiological and biochemical differences, but variations within species are usually more subtle.

Besides inter and intraspecific variations in UV-B sensitivity, other abiotic factors also alter and/or modify the plant responses as an outcome of the interactions. Under field conditions, plants usually experience several stresses simultaneously. The effect of enhanced UV-B radiation on plants can be modified by other co-occurring stresses or by simply changing environmental factors like atmospheric CO_2 (Bjorn et al., 1997), water availability (Manetas et al., 1997) and nutrient availability (Murali and Teramura, 1987; Levizou and Manetas, 2001).

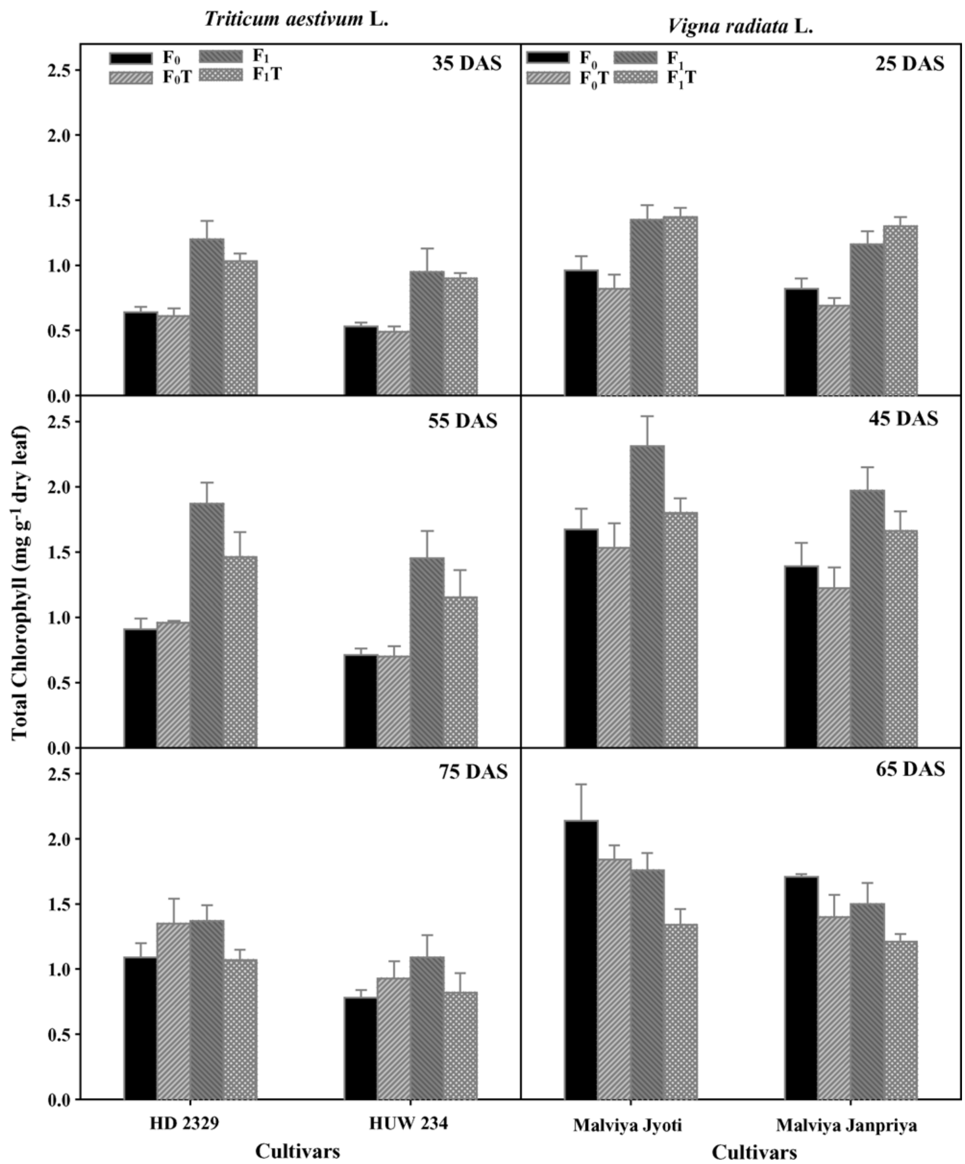

Fig. 1. Age wise changes in total chlorophyll content of control and sUV-B exposed *Triticum aestivum* L. (cv. HD 2329 and HUW 234) and *Vigna radiata* L (cv. Malviya Jyoti and Malviya Janpriya) cultivars with and without nutrients (bars represent ± 1S.E.).