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RELATIVE TOLERANCE IN *CAJANUS CAJAN* AND *CICER ARIETINUM* IN RESPONSE TO EXPOSURE TO SULPHUR DIOXIDE

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SO_2 and NO_2 have always been the worse culprit and in ambient environment they exist together. Of the two, oxides of sulphur are most extensively studied and most serious pollutants. The oxides of sulphur include six different gaseous compounds, sulphur monoxide (SO), sulphur dioxide (SO_2), sulphur trioxide (SO_3), sulphur tetroxide (S_2O_4), sulphur sesquioxide (S_2O_3) and sulphur heptoxide (S_2O_7). Out of these oxides of sulphur, SO_2 is of greater importance than the others. Many fold increase in combustion of fossil fuels, refining and smelting of sulphur containing ores, manufacturing of H_2SO_4, paper and pulp products emit large amount of SO_2 into the atmosphere (Akimotolt 1994).

Sulphur dioxide causes severe damage to vegetation under natural and control conditions (Verma and Agarwal 1996). Burning of coal is the single largest man-made source of SO_2 accounting to about 50% of the annual global emission. Part or all the sulphur requirements of plants may be met out by direct uptake of SO_2 from atmosphere, if it is present in low concentration (Chand and Singh 1988). On the other hand, if SO_2 concentration increases beyond certain critical level, respiration and other fundamental cellular processes are affected (Thomas 1991). According to Saxena and Saxena (1999), the ionic species namely, sulphite (SO_3^{-2}) and bisulphite (HSO_3^{-}) ions are responsible for the deleterious effects of SO_2. Sulphur dioxide is absorbed by the plants through stomata of leaves and it is then passed into intercellular spaces of mesophyll cells where it combines with water to form sulphurous acid (H_2SO_3), which causes necrosis, chlorosis and leaf abscission.

MATERIAL AND METHODS

The undertaken research work was carried out on two different leguminous crops widely grown in western Uttar Pradesh. The crops were studied for their relative sensitivity to different concentrations of sulphur dioxide, viz. 653, 1306, 2612 and 3918 $/gm^{-3}$. The choice of the above concentration was made to observe the limit of tolerance of the test plants to sulphur dioxide pollution. The crops selected for the study were : *Cajanus cajan* L. cv UPAS-120 and *Cicer arietinum* L. cv Avrodhi.

The effects were analyzed for proline and ascorbic acid contents, the parameters for relative sensitivity of plants to SO_2. Ascorbic acid content was measured by using method devised by Keller and Schwager (1977) and proline content was measured in the leaves by using the method devised by Bates (1973).

OBSERVATION AND RESULTS

The two test plants, viz. *Cicer arietinum* L. cv Avrodhi and *Cajanus cajan* L. cv UPAS-120 were observed for the effect of four concentrations of SO_2, i.e. 653, 1306, 2612 and 3918 μg m^{-3}. It was observed that sulphur dioxide had an adverse effect on the two plant species. The findings were correlated and discussed on the basis of the data collected.

Proline is an amino acid which is known to increase in content during stress. An increase in the amount of proline content was observed in the two cultivars against the exposure of the pollutants. However, with an increase in concentration of S*O_{2} the proline content was found to be slightly reduced in treated plants at the later stages. It was found highest during senescence in control plants (Table 1). Proline contents in *Cajanus cajan* and *Cicer arietinum* were high.

Ascorbic acid content is another biochemical component indicative of stress. It was found to enhance initially for all doses of SO_2, but reduced later with an increase in the age of plant for higher SO_2 concentrations. Untreated plants exhibited a regular increase at all the stages. Maximum reduction was observed in 3918 ⌠g m^{-3} of SO_2 by 19.17 and 20.87 per cent in *Cajanus cajan* and *Cicer arietinum* respectively at 80d indicating the sensitivity of the plant to higher concentrations of SO_2 (Table 1).

TABLE-1. Contents of proline and ascorbic acid in SO_2 fumigated leaves of *Cajanus cajan* and *Cicer arietinum* at 80d plant age.

Attribute (mg/g f. wt.)	**SO_2 (⁄g m^{-3})**						
	0	**653**	**1306**	**2612**	**3918**	**CD 5%**	**CD 1%**

Cajanus cajan								
Proline	0.441	0.571**	0.561**	0.512	0.404	0.098	0.061	
Ascorbic acid	6.993	5.613**	4.853**	5.571**	4.833**	0.551	0.390	
Cicer arietinum								
Proline	0.561	0.626**	0.661**	0.766**	0.741**	0.050	0.031	
Ascorbic acid	6.581	6.446	5.846*	5.710**	5.310**	0.741	0.521	

* Significant at 5% level, ** Significant at 1% level.

DISCUSSION

Sulphur dioxide causes an adverse effect on the plants subjected to fumigation. The plants exhibited a slight resistance initially as shown by an increase in proline and ascorbic acid contents in the leaves. This increase was later followed by a decrease which exhibits the susceptibility of the two cultivars to SO_2.

Proline is a basic amino acid found in high percentage in basic proteins and its content is reported to increase under physiological and pathological stress conditions (Jeykumar *et.al.* 2003). Proline accumulation was recorded as increasing with increasing concentration of SO_2 in early stage of the plant but decreased in later stage at highest concentration, i.e. 3918 µg m^{-3}. Under stress conditions, proline accumulates in order to make osmotic adjustments. Proline production also depends upon the ions and the degree of stress and the plant species to which the stress is imposed (Wimberg 1987; Peak *et al*. 1988; Yang *et al*. 1990). According to Fedina and Popova (1996) availability of energy rich compounds generated from photosynthesis and respiration may be the cause of increased accumulation of proline. A slight decrease in proline content of *Cajanus cajan* and *Cicer arietinum* at higher concentration of 2612 and 3918 μg m^{-3} SO_2 at later stage of the plant might be due to excess accumulation of ions over their scavenging potential (Katiyar and Dube 2001).

In response to SO_2 stress, ascorbic acid content was found to intially increase slightly, but upon further exposure decreased in the two plant species, *Cajanus cajan* and *Cicer arietinum*. Maximum decline in the level of ascorbic acid was found in *Cicer arietinum* followed by *Cajanus cajan*. Varshney and Varshney (1984) established a correlation between ascorbic acid content and resistance of plants. Heath (1994) reported that SO_2 dissolves in extracellular fluid and reacts with biological compounds producing free radicals. These free radicals interact with proteins and lipids in cell wall and cell membrane leading to production of more free radicals which increase the cell wall permeability (Pell and Dann 1991). The antioxidants are developed by plants as a defence against the free radical formation.

Ballantyne (1973) proposed that exposure to SO_2 might alter the ratio of oxidized to reduced sulphydryl groups in plants and the ascorbic acid might be reduced into DHA or oxalic acid or other convertible carbohydrates. In the present study, the regeneration of ascorbic acid might be low compared to its utilization for scavenging cytotoxic oxyradicals. A positive correlation has been reported between ascorbic acid content and cell division and expansion (Cordoba-Pedregosa *et al*. 1996; Arrigoni *et al*. 1997).

Boch pigeon pea (*Cajanus cajan*) and Chick pea (*Cicer arietinum*) can exhibit varying degrees of tolerance to sulphur dioxide (SO_2) expensive, but *Cajanus cajan* is considered more tolerant. It is shown through studies that Pigeon pea can adapt to air pollution, including SO_2. and *Cicer arietinum*, also impacted by air pollution, may show more pronounced effects on growth and yield, particularly at higher SO_2 concentrations. Additionally, research on the combined effects of SO_2 with other pollutants and the long-term impacts of SO_2 exposure on both plants is ongoing according to some research papers.

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