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Influence of Chromium Stress on Proline Accumulation in Soybean (*Glycine max* L. Merr.) Genotypes

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Abstract: Four genotypes of soybean (*Glycine max* L. Merr.) were taken for investigation to know their response towards chromium stress. On the basis of seedling growth vigour index and dry weight, the genotypes JS 355 and P 1 were found tolerant to chromium stress when compared to the other genotypes. The tolerant genotypes had shown higher proline contents in their shoots.

Key words: Chromium · Soybean · Proline · Vigour index · Tolerant index

INTRODUCTION

Chromium is one of the most toxic heavy metals which deteriorate the environment. The contamination of soil and water due to the indiscriminate use of chromium in leather, steel plating and dyeing industries is of serious of cones to plant and animal scientists for the past decades. In contrast to most trace metals such as cadmium, lead, mercury, aluminium and chromium persists in the environment as a complex, which posses a major hurdle in unraveling its physiological function in plants [1]. However, analysis of plant tissue for antioxidant enzymes and praline contents under chromium stress has been suggested as one of the useful parameters to measure the varietal tolerance to the heavy metal. Hence, the present investigation was undertaken to study the effect of chromium on the proline content of four genotypes (JS 355, P 1, CO 1 and CO 2) of soybean to assess their relative tolerance.

MATERIALS AND METHODS

The seeds of soybean (*Glycine max* L.) varieties (JS 355, P 1, CO 1 and CO 2) were procured from the Department of Pulses, School of Genetics, Nadu Agricultural University, Coimbatore, Tamil Nadu. The healthy seeds were evenly placed on sterilized petriplates lined with filter paper. The seeds were irrigated with ifferent concentrations (0, 5, 10, 25, 50, 100 and 200 mg L^{-1}) of chromium. The7th day seedlings were used to measure their growth, vigour index [2] and their dry weight. The method developed by Bates *et al*. [3] was used for the quantification of proline. 0.5 g of plant material (root and shoot) was homogenized using 10 ml of 3% aqueous sulphosalicylic acid. The homogenate was filtered through Whatmann No.1 filter paper and mixed with 2 mL of acid ninhydrin (1.25 g of ninhydrin + 30 mL of glacial acetic acid + 20 mL of 6 M phosphoric acid) and 2 mL of glacial acetic acid. The sample was heated for one hour at 100 °C in a water bath and followed by addition of 4 mL of toluene. This solution was mixed well and read at 520 nm in a UV-visible spectrophotometer. The results are expressed as □ mol g-1 fresh weight.?

RESULTS AND DISCUSSION

The seedling growth (Fig. 1), dry weight (Fig. 2) and vigour index (Fig. 3) of four genotypes of soybean are given. Growth is chiefly expressed as a function of genotype to environmental condition. Presence of chromium in the external environment leads to changes in the growth and development pattern of the seedlings. There was a reduction in growth, dry weight and vigour index in four genotypes of soybean at increasing concentrations of chromium. Similarly the variety JS 355 was found less susceptible than the other tested. A similar reductions in germination and growth of soybean genotypes (CO 1, CO 2, JS 355 and P 1) under chromium stress recently has been reported [4]. However, the change in proline in those genotypes have not been

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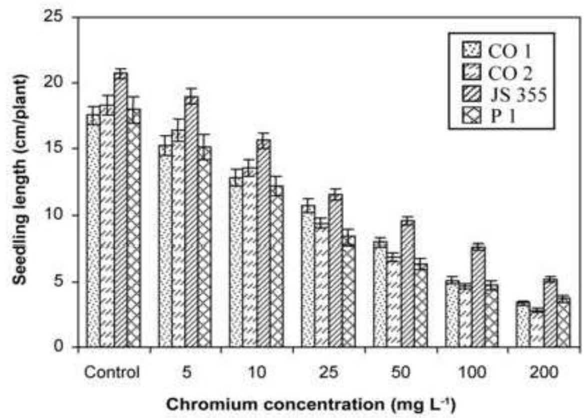

Fig. 1: Effect of different concentrations of chromium on seedling growth of four varieties of *Glycine max* L.

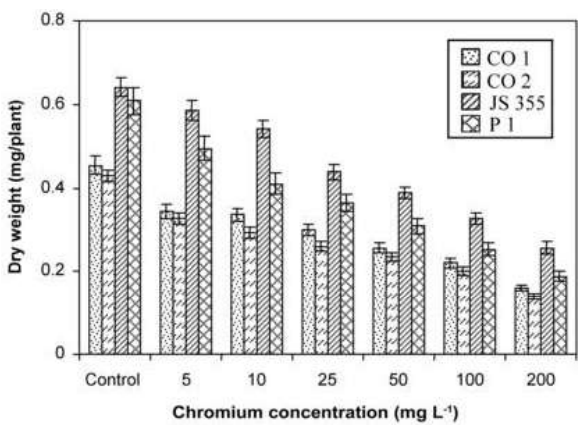

Fig. 2: Effect of different concentrations of chromium on dry weight of four varieties of *Glycine max* L.

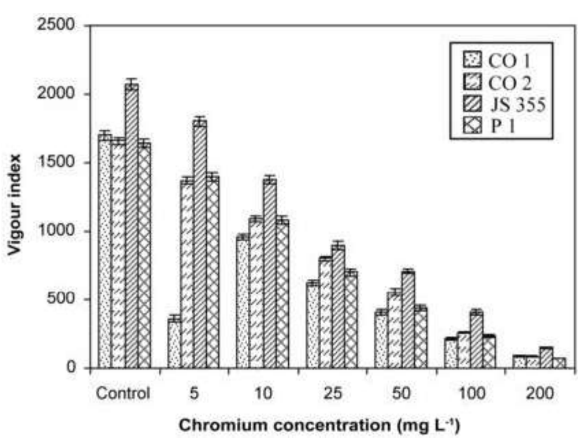

Fig. 3: Effect of different concentrations of chromium on vigour index of four varieties of *Glycine max* L.

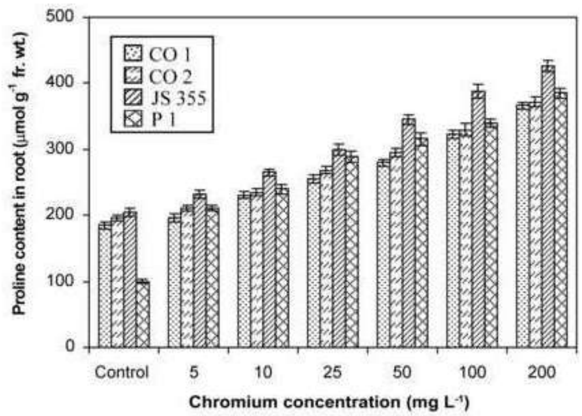

Fig. 4: Effect of different concentrations of chromium on proline content (root) of four varieties of *Glycine max* L.

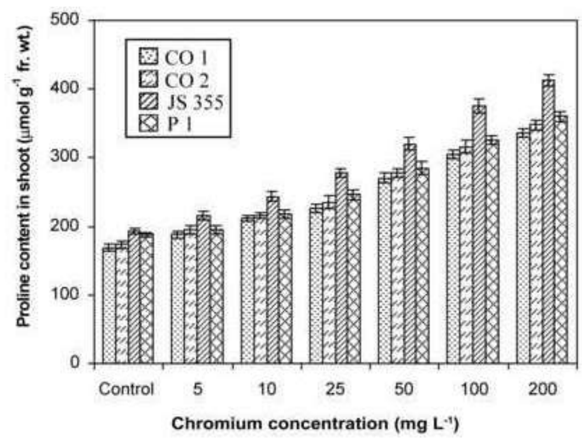

Fig. 5: Effect of different concentrations of chromium on proline content (shoot) of four varieties of *Glycine max* L.

tested, unlike in the present study. The reduction in seedling growth under chromium stress might be due to the poor root growth which inhibits transportation of water and nutrients to the shoot of the plants. In addition to this, chromium transport to the aerial part of the plant can have a direct impact on cellular metabolism of shoots contributing to the reduction in seedling growth [1]. Similarly, the decrease in the weight of the seedling is mainly due to the inhibition of water uptake [5]. When the concentration of chromium solution increases, the vigour index of the soybean varieties decreases this study showed an inverse relation between the concentration of chromium and the growth of the seedling. This is probably due to the influence of chromium on the metabolic activities of the seedling [6]. Proline apparently is the only amino acid that accumulates to a great extent in the leaves of many plants under stress. Accumulation of proline starts under mild water stress and the magnitude of accumulation is proportional to the severity of stress. In the present investigation, higher proline content was observed in tolerant genotypes and a gradual increase in proline could be noted with increasing chromium concentrations (Figs. 4 and 5). Thus proline accumulation under such condition may also be operative as usual in osmotic adjustment while accumulation of proline in tissues can be taken as a dependent marker for genotypes tolerant to stress. The higher proline content was observed in the variety JS 355 followed by P 1, CO 1 and CO 2 varieties. It might be attributed to the strategies adapted by the plants to cope up with chromium toxicity as proline has multiple functions such as osmoticum, scavenger of free radicals, protective role of cytoplasmic enzymes, source of nitrogen and carbon for post-stress growth, stabilizer of membranes, machinery for protein synthesis and a sink for energy to regulate redox potential [7,8]. Proline acts as a cytoplasmic osmoticum as it accumulates to a higher degree under stress conditions, which may play an adaptive role for any stress tolerance. Similar results were made in screening of rice genotypes [9], chickpea genotypes [10] and sugarcane genotypes [11] under salt tolerance. Thus, it may be concluded that the four genotypes show different levels of proline accumulation under chromium stress. The detailed investigation on the tolerant genotypes would be useful to know the mechanism of proline accumulation under chromium stress.

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