Effect of cadmium on tomato growth and yield attributes

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ABSTRACT

The seeds of (Lycopersicon esculentum Mill.) variety Pusa Ruby were used to evaluate as to what effect this metal cadmium would create on the vegetable crop plant at different stages of its growth and development. At lower concentration treatment showed enhanced percentage of germination, survival percentage, plant height, root length, early flowering more pollen viability, increase in total chlorophyll content. Apart from this metal analysis was also studied. Different yield components were under taken. The higher concentration of heavy metal cadmium treatments showed inhibitory effect in general.

Keywords: Lycopersicon esculentum, Cadmium, Seed germination and Metal analysis.

INTRODUCTION

Heavy metals are integral components of ecosystem. The characteristics feature of heavy metal is poisoning and resulting in the inactivation of enzyme systems. All heavy metals are potentially toxic at elevated concentrations [1]. Heavy metals have been shown to effect chlorophyll content and biosynthesis [2], germination and seedling growth [3]. Heavy metals in growth media can function as stressors, causing physiological constrains that decrease plant vigour and inhibit plant growth [4].

Very high cadmium concentrations have been found to be carcinogenic, mutagenic and teratogenic for a large number of animal species [5]. Cadmium is a major environmental contaminant of air, water and soil [6]. Excess cadmium causes a number of toxic symptoms in plants i.e. growth retardation, inhibition of photosynthesis, induction and inhibition of enzymes, altered stomatal action, water relations, efflux of cations and generation of free radicals. Cadmium has been shown to affect various aspects of metabolism in different plant systems [7-8]. At low concentrations, Cd acts as a photophosphorylation inhibitor in spinach chloroplasts [9].
MATERIALS AND METHODS

A series of pots were filled with equal amount of soil and then different concentrations of cadmium i.e., 50, 100, 200, 300 and 400 mg/kg is added per kg of soil and mixed thoroughly. Pots without the addition of metals were constituted as the controls. Equal number of sterilized seeds of tomato were compared on the basis of growth and yield. To estimate the pollen viability, pollen grains of treated as well as control were placed in equal quantity of acetocarmine 1% on a slide and gently warmed and observed under microscope. The filled and stained grains were regarded sterile. The estimation of total chlorophyll was done in the matured leaf by spectrocralorimeter following the method described by Arnon (1949) of both control as well as treated. Care was taken to select the leaves at same position and age of the plant for the determination of their chlorophyll content in different treated and control samples.

For metal analysis the plants were uprooted at the time of harvest, then washed with deionised water and dried in oven at 60°C for 48h. The samples were then finely powdered and digested in concentrated nitric acid and perchloric acid (5:1) until a clear solution was obtained (Barman and Lal, 1994). It was then filtered reconstituted to the desired volume with double distilled water and analysed in Atomic Absorption spectrometer (Nebul son, 608). The analysis of heavy metal cadmium was done for root, stem, leaf and fruit of Lycopersicon esculentum at low and higher concentrations. The data represented average of the three replicates have been analysed statistically along with correlation and represented in figures wherever necessary.

RESULTS AND DISCUSSION

The control samples showed a germination of 95% there was a decreased percentage gradually with increasing concentration. No change in germination was also recorded in Cd 50mg/kg treated samples. But, in remaining all concentrations there was a decreased (Table-I). The survival percentage of seedlings, decreased gradually in all the Cd treated samples as increasing the level of metal (Table-I). The survival percentage of seedling in the control samples was 89.0 and where it was 83.0, 76.0, 70.0, 62.0 & 54.0 percentages. In 50, 100, 200, 300 and 400mg/kg respectively in treated samples. In the control samples, the average plant height was 61.5cm. Increase in plant height was observed in 50, 100 & 200mg/kg treatments, where they were 62.3, 64.5 & 61.7cm respectively. 56.8 & 51.5cm plant height was recorded in 300 and 400mg/kg treated samples respectively. Some plants with dark green leaves was observed in Cd 100mg/kg soil. Burning of shoot apical region was observed from high concentration (400mg/kg) of Cd (Plate-I, Fig-b). In the control samples the average root length was 10.2cm. Root length was increased in 100mg/kg Cd treated soil (Table-I) then followed decrease in root length as increasing concentrations. Stouter root with less number of lateral roots were seen at higher concentration (400mg/kg) of Cd (Plate-I, Fig-d). An average number of flowers (7.0) were formed in control samples. Decrease in the number of flowers was seen in all Cd treated samples as increasing in their concentration (Table-I), but in Cd 100mg/kg, number of flowers same as controls. In Cd 300 and 400 mg/kg treated samples, there was initiation of flowering, but there was no fruit formation. In control flowers, the number of petals was 5.0. Flowers from Cd 50mg/kg treated soil shown six petals unequally and two of them fused (Plate-I, Fig-f). Five (5.0) petals were seen in 100 & 200mg/kg and 6.0 petals were also observed in Cd 300 & 400mg/kg treated soil. Decrease in the pollen viability was seen in all treated samples as increasing in their concentration (Table-I). 81.2% pollen viability was recorded in the control samples. The percentage of pollen viability was 80, 77, 71, 40 & 40 in 50, 100, 200, 300 and 400 mg/kg treated samples respectively. In control average number of fruits formed were 6.0. Whereas in the treated samples of Cd 50, 100 & 200 mg/kg they were 5.0, 6.0 and 5.0.
respectively. No fruit formation was observed in Cd 300 & 400 mg/kg treated samples. Delay ripening of fruits were seen in Cd 50mg/kg. In control samples, the average fruit weight was 51.0g and fruit girth was 11.0cm in all Cd treatments fruit weight and girth decreased as increasing concentrations. In Cd, 50mg/kg fruit girth was increased.

Chlorophyll content was calculated at the time of flowering stage. Chlorophyll a, b and total chlorophyll content in plants obtained from Cd treated soil decreased gradually as increasing concentrations and when compared to controls also there was decreased all treated samples. But in some higher concentrations the chlorophyll content was showed haphazardly increasing (Fig-I). In all cadmium treated samples showed more absorption in all the plant parts (Table-II).

<table>
<thead>
<tr>
<th>Conc. in mg/kg</th>
<th>% of germination</th>
<th>Survival percentage</th>
<th>Plant height (cm)</th>
<th>Root length (cm)</th>
<th>Number of flowers/plant</th>
<th>Pollen viability %</th>
<th>Average number of fruits</th>
<th>Fruit girth (cm)</th>
<th>Fruit weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>95</td>
<td>89</td>
<td>61.5±0.580</td>
<td>10.2±0.129</td>
<td>7±0.261</td>
<td>81.2</td>
<td>6±0.216</td>
<td>11.0±0.216</td>
<td>51±0.8</td>
</tr>
<tr>
<td>50</td>
<td>95</td>
<td>83</td>
<td>62.3±0.223</td>
<td>10.4±0.365</td>
<td>7±0.261</td>
<td>80.0</td>
<td>5±0.173</td>
<td>11.4±0.238</td>
<td>50.12±0.420</td>
</tr>
<tr>
<td>100</td>
<td>92</td>
<td>76</td>
<td>64.5±0.258</td>
<td>10.1±0.391</td>
<td>6±0.216</td>
<td>77</td>
<td>6±0.216</td>
<td>11.0±0.216</td>
<td>49.5±0.129</td>
</tr>
<tr>
<td>200</td>
<td>84</td>
<td>70</td>
<td>61.7±0.472</td>
<td>10.0±0.129</td>
<td>5±0.216</td>
<td>71</td>
<td>5±0.173</td>
<td>10.8±0.294</td>
<td>48.3±0.163</td>
</tr>
<tr>
<td>300</td>
<td>70</td>
<td>62</td>
<td>56.8±0.141</td>
<td>9.5±0.191</td>
<td>5±0.173</td>
<td>6.5</td>
<td>40</td>
<td>-</td>
<td>-</td>
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<tr>
<td>400</td>
<td>58</td>
<td>54</td>
<td>51.5±0.288</td>
<td>8.3±0.20</td>
<td>2±0.216</td>
<td>6.5</td>
<td>40</td>
<td>-</td>
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</table>

<table>
<thead>
<tr>
<th>Metal</th>
<th>Root</th>
<th>Stem</th>
<th>Leaf</th>
<th>Fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower</td>
<td>Cd</td>
<td>0.310</td>
<td>0.200</td>
<td>0.143</td>
</tr>
<tr>
<td>Higher</td>
<td>Cd</td>
<td>0.619</td>
<td>0.512</td>
<td>0.381</td>
</tr>
</tbody>
</table>

Hg and Cd inhibit both seed germination and seedling growth of groundnut, sunflower and gingerly [10] in higher concentration. The same trend towards seed germination and seedling growth was also recorded in present study with tomato.
Cd concentrations above 5µg/g resulted in a decrease in all growth parameters. Similar decrease at higher Cd levels in growth parameters have also been observed in different crops by a number of workers [11-14].

CONCLUSION

In the present investigation, at lower concentration of cadmium treatment showed enhanced percentage of germination, survival percentage, plant height, root length, early flowering, more pollen viability, increase in total chlorophyll content. The higher concentration of cadmium treatments showed in a decrease in all growth parameters.

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REFERENCES