Effects of Some Heavy Metals on in vitro Pollen Germination and Tube Growth of Apricot (Armenica vulgaris Lam.) And Cherry (Cerasus avium L.)

Nazmi Gür and Aykut Topdemir

Department of Biology, Faculty of Science and Art, Fırat University, 23169 Elazig, Turkey

Abstract: The aim of the study was to determine the influence of heavy metals (Cd, Cu, Hg and Pb) on the pollen germination and tube growth of Apricot and Cherry. This study demonstrated heavy metals led to a significant decrease pollen germination and tube growth of apricot and cherry. There was a reduction in pollen germination and tube elongation as metal concentrations increased. Cu had the highest toxic effect on pollen of apricot while Pb had the least effect. Cherry pollen germination and tube growth was mostly inhibited by Hg and Cd, but only weakly by Pb.

Key words: Pollen germination • Apricot • Cherry • Heavy metals

INTRODUCTION

Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning for human, animal, plant and microorganisms [1-6]. Over the last decades, environmental contamination with heavy metals has increased drastically.

Heavy metals have recently received the attention of researchers all over the world, mainly due to their harmful effects on plant. The toxic effects of metals have also been intensively studied at the level of biochemical-physiological process such as photosynthesis [7], transpiration [8], enzyme activity [9] or metal accumulation in tissue [10].

Pollen germination and tube growth are used to detect biological activity of various environmental pollutants such as anthropogenic compounds of the atmosphere, heavy metals, pesticides, acid rain [11-17]. In this paper we report effects of the four heavy metals (Cd, Cu, Hg and Pb) on in vitro germination and tube growth of pollen in apricot and cherry plant, which has an economic importance.

MATERIALS AND METHODS

Pollens of apricot (Armenica vulgaris Lam) and cherry (Cerasus avium L.) flowers were obtained from Bavunusagi village of Elazig which is situated east part of Turkey. Flowers were placed in polyethylene containers and the experiments were done without any delay in laboratory. Flowers from the same tree were used in every sequence of the experiment. Standard solution of each metal (30, 60, 90, 120 and 240 µM) were prepared with distilled water from CuCl₂, PbCl₂, HgCl₂ and CdCl₂.

Pollens were germinated in Brewbaker and Kwack culture solution (culture medium). Heavy metal solutions and culture medium at the same volumes were used. Sterile 3 micro slides were prepared for each heavy metal solutions (2 for experiment group, 1 for control group). A 50 µl culture solution was dripped to 2 various areas on each slide. 50 µl heavy metal solutions for experiment groups and 50 µl deionised water for control group (CG) were added onto slides. Pollens on anther were homogeneously cultivated by a sterile syringe into the culture medium under stereomicroscope. Petri dishes (15 cm diameter) with a moist filter paper lining the lower plate served as an improvised humidity chamber. Two glass rods were placed parallel at about 4 cm apart on the moist filter paper to facilitate the handling of the pollen cultures. Then, the petri dishes were settled in incubator at 22±2°C. Each germination medium was fixed with 10 % ethyl alcohol after 3 hours and then lamella were closed. Germination percentages and tube lengths of pollens were determined under light microscope by method of Shivanna and Rangaswamy [18].

Mean and standard deviation were calculated for pollen germination and tube length in each treatment and control of each species. Multiple range tests (Duncan)
were used to determine significant differences among means (P<0.05) in either pollen germination or pollen tube length.

**RESULTS**

Tables 1 and 2 summarize the results for the effect of heavy metals (Cd, Cu, Hg and Pb) on pollen germination and tube growth of pollen in apricot and cherry plants.

**Table 1:** The effect of Cd, Pb, Hg and Cu on pollen germination and tube length in apricot (*Armenica vulgaris* Lam.)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Polen germ. (%)</th>
<th>Tube length (µ)</th>
<th>Treatment</th>
<th>Polen germ. (%)</th>
<th>Tube length (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG</td>
<td>72.80a</td>
<td>189.05a</td>
<td>CG</td>
<td>72.80a</td>
<td>189.05a</td>
</tr>
<tr>
<td>30</td>
<td>66.98c</td>
<td>73.20c</td>
<td>30</td>
<td>56.15b</td>
<td>152.10b</td>
</tr>
<tr>
<td>60</td>
<td>52.48d</td>
<td>65.20c</td>
<td>60</td>
<td>53.72c</td>
<td>106.05c</td>
</tr>
<tr>
<td>90</td>
<td>41.71e</td>
<td>32.25d</td>
<td>90</td>
<td>45.56d</td>
<td>95.20c</td>
</tr>
<tr>
<td>120</td>
<td>19.53f</td>
<td>12.65e</td>
<td>120</td>
<td>41.25e</td>
<td>68.95d</td>
</tr>
<tr>
<td>240</td>
<td>23.22f</td>
<td>9.70d</td>
<td>240</td>
<td>31.25e</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2:** The effect of Cd, Cu, Hg and Pb on pollen germination and tube length in cherry (*Cerasus avium* L.)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Polen germ. (%)</th>
<th>Tube length (µ)</th>
<th>Treatment</th>
<th>Polen germ. (%)</th>
<th>Tube length (µ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG</td>
<td>88.37a</td>
<td>181.70a</td>
<td>CG</td>
<td>88.37a</td>
<td>181.70a</td>
</tr>
<tr>
<td>30</td>
<td>68.84b</td>
<td>85.50b</td>
<td>30</td>
<td>50.00b</td>
<td>85.85b</td>
</tr>
<tr>
<td>60</td>
<td>34.38d</td>
<td>46.95c</td>
<td>60</td>
<td>32.94c</td>
<td>26.35c</td>
</tr>
<tr>
<td>90</td>
<td>22.68d</td>
<td>35.30c</td>
<td>90</td>
<td>30.68d</td>
<td>23.90c</td>
</tr>
<tr>
<td>120</td>
<td>19.58e</td>
<td>46.45c</td>
<td>120</td>
<td>28.84e</td>
<td>23.25c</td>
</tr>
<tr>
<td>240</td>
<td>11.41f</td>
<td>15.15d</td>
<td>240</td>
<td>23.12f</td>
<td>9.70d</td>
</tr>
</tbody>
</table>

As can be seen, there was a reduction in pollen germination and tube elongation as metal concentrations increased. Apricot pollen germination was mostly inhibited as 90 µm as by Cu. 120 and 240 µM Hg was shown mostly inhibitor effect on apricot pollen germination. Cd was shown weakly affect on apricot pollen germination. Cherry pollen germination mostly inhibited by Hg, but only least by Pb. Significant differences (P<0.05) are observed between all heavy metal concentrations on apricot and cherry pollen germination.

Pollen tube elongation of both plants were inhibited by all heavy metal concentrations. Significant differences (P<0.05) on apricot and cherry pollen tube length are not observed between the treatments with all heavy metals at 60 and 90 µm. In addition, no statistically significant differences were found between 60, 90 and 120 µm concentrations of Hg and Cu on pollen tube length of apricot plants. Cu was shown mostly inhibitor effect on apricot pollen tube elongation, but only weakly by Pb. Pollen tube elongation in cherry was mostly inhibited by Hg and Cd.

**DISCUSSION**

Our study exhibited that Cu had the highest inhibition on apricot pollen germination and tube growth. As known, Cu is an essential role in many physiological pathways in plant, such as photosynthesis, respiration, carbohydrate distribution, protein metabolism etc. But it is a toxic to plant at high concentration. Phytotoxic effect of Cu on plant are higher than most of heavy metal contaminants. It was reported that toxic effect of Cu and other heavy metals on wheat growth was as follow: Cd>Cu>Ni>Zn>Pb>Cr [19]. Another studies demonstrated that Cu was the second most effective metal (within Cd, Hg, Co, Pb and Zn) on the seed germination, root elongation and coleoptile and hypocotyls growth in *Triticum aestivum* and *Cucumis sativus* [20]. Our observations are in accordance with the above reported results. Furthermore, another study has indicated that Cu, Ni and Hg most inhibited elements on pollen germination in tobacco plant [16]. Others have also reported that compounds with Hg among heavy metals prevent DNA replication and protein synthesis, causing mitotic anomalies and that Cu has similar effects, causing chromosome anomalies [21]. Our results lend credence to this report. However, different effect of heavy metal application has been also observed in our other experimental model in which we reported that Cu weakly affected on pollen germination and tube growth in quince.
and plum plant [17]. This different observations may be due to different toleration of different plants to heavy metal stress.

Xiong and Peng [22] revealed that Cd at 2.51 mg/ml or higher inhibited pollen germination of five species and tube growth was inhibited at concentrations of 1.58 or higher while it stimulate more pollen tube growth below 1.58 mg/ml Cd. However, when this study compared with our study regarding the pollen tube growth stimulation under different conditions it was seen that pollen tube growth was not stimulated due to high concentrations of Cd. This result is consistent with our studies without Cd, which has an important role in the pollen tube growth but high Cd may not favor to the pollen tube growth as in our case.

Growth of apricot and cherry with and without Pb was compared under similar condition. Both species exhibited no remarkable differences in growth. Lead is common heavy metal pollutant, released from loaded gasoline and industrial processes and Pb has not been shown to be essential in plant metabolism and demonstrated to stimulate formation of free radicals and reactive oxygen species which can damage plant cells [23, 24]. In plants, it can adversely affect different processes such as germination, growth and photosynthesis etc [25]. In another study on the bioconcentrations of heavy metals in the plant structure, it has also been claimed that Cd, Cu, Hg and Ni are more toxic than Pb and Zn for plants [26]. An [27] indicate that Cu is more toxic than Pb to the plants in their study. Our results are in accordance with the above reported results.

Based on the results, we concluded that heavy metals was responsible for a decrease in the pollen germination and tube growth of the apricot and cherry plant. Lowered heavy metals concentration in the soil may be important to obtain more agricultural products.

REFERENCES


