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Plant Physiology

The Effect of Co on Catalase Activity in Vegetable Plants

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ABSTRACT. The paper deals with the influence of $CoCl_2$ solution 0.02% on catalase activity in leaves and fruits of tomato (*Lycopersicum esculentum Mill.),* eggplant (*S. melongena*) and pepper (*Capsicum annuum).* Catalase is one of the components of the cell antioxidant factors. Its increased activity is essential for plant protection from the active form of oxygen. Pre-sowing treatment of the plant seeds with cobalt increases the enzyme activity in different phases of vegetation. Catalase activity in tomato leaves reaches its maximum in the phase of grown fruit, in eggplant leaves during blooming and in pepper leaves in the budding phase. Increased catalase activity is observed in the eggplant fruit, while in pepper fruit it is reduced. *© 2014 Bull. Georg. Natl. Acad. Sci.*

Key words: *Cobalt, catalase, oxygen, antioxidant factor, singlet oxygen, vegetable plants, enzyme.*

The products of incomplete oxidation of oxygen such as oxygen compounds, superoxide radicals, singlent oxygen and others have harmful effect on the cell. Due to the biological activity of these compounds they are called active forms of oxygen [1].

Active forms of oxygen are produced continuously in a cell, which is a normal metabolic process. Its concentration is very small – 10_8, 10_{11}. Active forms of oxygen participate in cellular defence reactions against pathogens, but in unfavorable conditions (drought, mechanical damage, the action of herbicides and pesticides) it accumulates in a large amount, causing serious disorders that damage biological cell membranes (due to lipid peroxide oxidation), leading to the damage of cell organoids. As a result, the process of cell division is hindered and eventually the cell dies [2].

Cell protection from the active forms of oxygen is provided by the action of an antioxidant factor, which is realized in enzymatic or non-enzymatic form [3]. In the first case the enzymes including catalase inactivate active forms of oxygen. In addition, there are other mechanisms of protection from active forms of oxygen, for example, reduction of the concentration of molecular oxygen proceeds through enhanced photorespiration in plants and in mitochondria through alternative oxidize activation. Besides, in response to accumulation of active forms of oxygen the mitochondrial inner membrane opens the pores, which seems to be related to the release of protons. Consequently, there begins stimulation of respiration and “utilization” of O_2 [4]. Plants characterized by high activity of the antioxidant factor are more resistant to the stress factors, including water shortage. Micronutrients affect the activity of active forms of oxygen in cells [5].

We have studied the effect of Co on the activity of catalase in the leaves and fruits of tomato, eggplant and pepper.

Material and Methods

The objects of the study were the vegetables widespread in western Georgia: the eggplant variety "Brunette" (*S. melongena*), tomato "Wonder of Market" (*Lycopersicum esculentum Mill.)* and pepper variety "Hot Pepper" (*Capsicum annuum).* The seeds were placed in 0.02%-solution of $CoCl_2$ for 24 hours; after drying the seeds were sown in Petri dishes to develop water crops, Knopf solution was the nutrition. The control material was treated with distilled water in the same way. There were 6-12 water plants per analysis, where the middle tier leaves were used. The data were statistically processed with Student method.

Catalase activity was determined with spectrophotometric method at 240 sec. According to the optical density change of H_2O_2 enzyme preparation was received from 1 g of crude material. Reaction mixture contained 2.8 ml of 0.005M phosphate buffer PH 7.0- 7.5 as well as 0.1ml of 2% H_2O_2 and 0.1 ml enzymatic preparation. Total volume of the reaction solution was 3 ml. It must be taken into account that the large concentrations of H_2O_2 have negative effect on the enzymes.

The reaction was carried out at 25°C during 3min with the intervals of 0.5–1.0 min. The control variant was the reaction solution without the substrate [6].

Result and Discussion

The studied plants differ from each other by catalase activity. The enzyme activity varies in different phases of vegetation in all the plants.

Catalase activity in tomato leaves is higher before flowering, than in the phase of flowering. With the appearance of the first fruit it decreases and increases again in the phase of growing fruit and the increase is greater, than before blooming – in the phase of budding.

Under the influence of cobalt the catalase activity increased in tomato leaves in all the phases of vegetation. However, there is not a big difference compared to the control variants with no dynamic changes in the enzyme activity. Under the influence of cobalt the catalase activity also increased in the grown fruit of tomato.

In the leaves of eggplant the catalase activity is higher in the stage of appearance of 5-6 leaves than in the budding phase. In the flowering phase the enzyme activity increases, and in the fruit bearing phase it decreases again. Yet it is higher, than in the budding phase.

Under the influence of Co the catalase activity in the eggplant leaves grew in the later phases of vegetation, in particular, during blooming and fruit bearing. In mature eggplant fruit the catalase activity is lower, than in the leaves. Under the action of cobalt the catalase activity dramatically increased in eggplant fruit (control 23.6, test - 32.3).

Catalase activity in pepper leaves was the highest in the budding phase decreasing in the next phases. As to tomato and eggplant no more increase in catalase activity was observed in the phase of grown fruit. In the cobalt treated variant the enzyme activity dramatically increased in all the phases compared to the control one, while the dynamics of the enzyme activity did not change. Catalase activity is much lower (19.0) in the grown fruits, than in the leaves of pepper. Cobalt treatment reduced enzyme activity even further (16.0), which is not observed in tomato and eggplant fruits. Increased activity of catalase contributes to the growth of a plant resistance to active forms of oxygen. Co influence increases the activity of certain enzymes, such as superoxide dismutase, which in its turn causes the increase of catalase activity [2,4].The increase of catalase activity might be connected to activation of other bio-

Table.

The effect of $CoCl_2$ solution 0.02 % on catalase activity in the leaves and fruits of plants

Plant	5-6 leaf phase	Budding phase	Flowering phase	First fruit bearing phase	Leaves in grown fruit phase	fruits
Tomato Contr.	29.0±2	31.0±1	26.4±1	24.0±0,3	32.9±2	33.4±3
test	30±1	32.4±3	24.5±2	25.0±1	33.3±3	34.6±1
Eggplant Cont.	33.9±3	24.0±1	31.0±3	26.1±1	24.0±0,9	23.6±2
test	35.0±2	26.8±0,3	36.6±2	32.0±3	28.5±1	32.3±1
Pepper Contr.	31.0±2	33.8±0,9	30.6±1	26.6±2	25.2±1	19.0±2
test	36.0±1	37.3±3	34.3±3	28.8±1	27.5±1	16.0±3

chemical processes caused by the action of Co since that microelement is the activator of many enzymes enhancing the metabolic processes. Catalase activity is higher in active bodies (Table 1).

Conclusion

The vegetable plants investigated differ from each other by catalase activity. Enzyme activity varies in different phases of vegetation.

Pre-sowing treatment of seeds with $CoCl_2$ solution 0.02 % increased catalase activity in the grown fruits of tomato and eggplant, while in pepper fruits it decreased.

The dynamics of catalase activity can be explained by the peculiarity of plants (tomato, eggplant and pepper) having technical, physiologically mature, young fruits, buds and flowers at the same time, which causes physiological changes in plant, due to which they remain active even in the later phases of vegetation and, consequently, catalase activity is high.

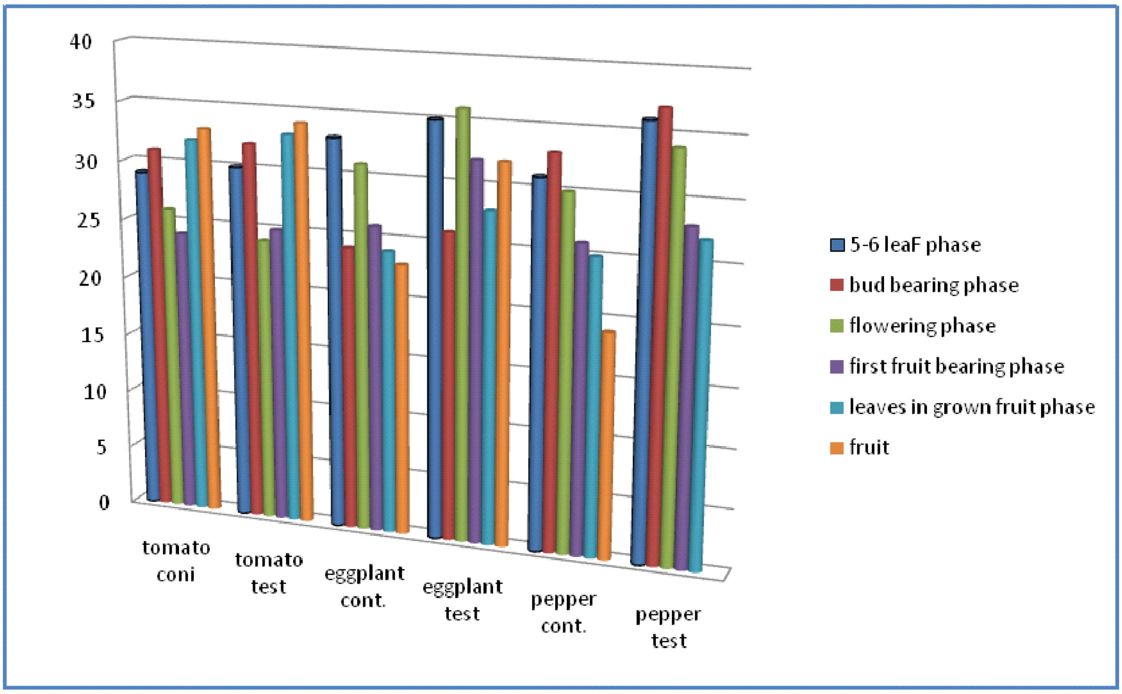

Fig. The effect of $CoCl_2$ solution 0.02 % on catalase activity in the leaves and fruits of the studied plants

მცენარეთა ფიზიოლოგია

Co-ის გავლენა ბოსტნეულ მცენარეებში კატალაზას აქტივობაზე

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შესწავლილია $CoCl_2$-ის 0,02%-იანი ხსნარის გავლენა პომიდვრის (*Lycopersicum esculentum Mill.*), ბადრიჯნის (*S.melongena*) და ცხარე წიწაკის (*Capsicum annuum*) ფოთლებსა და ნაყოფებში კატალაზას აქტივობაზე ვეგეტაციის სხვადასხვა ფაზაში.

საკვლევი მცენარეები ერთმანეთისაგან განსხვავდებიან კატალაზას აქტივობით, ფერმენტის აქტივობა ყველა მცენარეში ცვალებადობს ვეგეტაციის სხვადასხვა ფაზაში.

პომიდვრის ფოთლებში კატალაზას აქტივობა ყველაზე მაღალია ყვავილობის წინ, ბადრიჯნის ფოთლებში 5-6 ფოთლის გამოღებისას, ხოლო წიწაკის ფოთლებში კოკრების გამოღების ფაზაში.

$CoCl_2$-ის 0,02%-ი ხსნარით საკვლევი მცენარეების თესლების თესვისწინა დამუშავებამ ფოთლებში კატალაზას აქტივობა გაადიდა ვეგეტაციის ყველა ფაზაში, ფერმენტის აქტივობის დინამიკა არ შეცვლილა.

კობალტით დამუშავებამ კატალაზას აქტივობა ყველაზე მეტად გაზარდა ბადრიჯნის ფოთლებში ვეგეტაციის უფრო გვიან ფაზებში — ყვავილობისას და ნაყოფების გამოღებისას.

საკვლევ მცენარეთა ზრდასრულ ნაყოფებში კობალტის გავლენით კატალაზას აქტივობა ყველაზე მეტად გაიზარდა ბადრიჯნის ნაყოფებში, უფრო ნაკლებად პომიდვრის ნაყოფებში, წიწაკის ნაყოფებში კი ფერმენტის აქტივობა შემცირდა.

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