EFFECTS OF VANADIUM COMPOUNDS ON PLANT PHOTOSYNTHESIS

EFECTELE COMPUŞILOR VANADIULUI ASUPRA FOTOSINTEZEI PLANTELOR

OANCEA Servilia[1], AIRINEI A.[2], OANCEA A.V.[3]
[1]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[2]Institute of Macromolecular Chemistry "P.Poni", Iasi, Romania
[3]"Al.I. Cuza" University Iasi, Romania

Abstract. *The effect of vanadium on growth and performance of photosynthetic apparatus of plants is controversial. In general, the toxicity of vanadium compounds is low. Pentavalent compounds are the most toxic and the toxicity of vanadium compounds usually increases as the valence increases. The effect of the treatment with vanadium on growth and photosynthesis for pepper plants is presented in this work. Pepper seeds were planted in the University of Agricultural Sciences and Veterinary Medicine Iasi greenhouse and they were grown in pots, in optimal conditions. After that we treated the plants separately with solutions containing different vanadium salts. In order to accomplish the goal of this experiment 20 ml solution were poured into the soil at the root of each plant. The procedure was performed once a week for two weeks in a row. A week after the end of the treatment the analysis of the photosynthetic activity was performed. Our experiments showed that the vanadium action is low but it increases as the valence increases.*

Key words: organically-chelated vanadium compounds, photosynthetic pigment

Rezumat. *Efectul vanadiului asupra creşterii şi performanţei aparatului fotosintetic al plantelor este controversat. In general, toxicitatea compuşilor vanadiului este mică. Compuşii pentavalenţi sunt cei mai toxici şi toxicitatea lor creşte cu valenţa. In această lucrare este prezentat efectul tratamentului cu compuşi ai vanadiului asupra creşterii şi fotosintezei la plantele de ardei. Seminţele de ardei au fost semanate la sera Universităţii de Ştiinţe Agricole şi Medicină Veterinară Iasi şi au fost crescute în ghivece în condiţii optime. plantele au fost tratate separat cu soluţii conţinând diferite săruri ale vanadiului. Pentru a realiza acest lucru la rădăcina fiecărei plante a fost picurată 20ml de soluţie şi această procedură a fost reluată două săptămâni la rând. După o saptămână de la sfârşitul tratamentului s-a realizat analiza activităţii fotosintetice. Experimentele noastrea arată că acţiunea vanadiului este mică dar aceasta creşte cu valenţa elementului.*

Cuvinte cheie: compuşi chelatici cu vanadiu, pigmenţi fotosintetici

INTRODUCTION

The effect of the element vanadium on growth and on the performance of photosynthetic apparatus of plants is controversial. The authors (Kasai M,., 1999) analyzed the concentration of V in soil water and examined the effect of such concentrations of vanadate on plant growth and metabolism. Vanadate-treatment

experiments with rye or wheat showed that 0.1 mM vanadate had slight effects on seed germination, growth, photosynthesis, respiration, contents of cellular various components etc. Alvarez and co-worker (Alvarez, 2002) have shown that higher concentrations of vanadium added to soil or in foliar sprays significantly increased the vanadium content of the lettuces, but they did not affect the yields of either fresh or dry matter. On the other hand, other authors (Tham, 1999), examining the responses of mycelia of *Ganoderma lucidum* to vanadium, selenium and germanium over a wide range of concentrations and they found that Se and V are highly toxic, but Ge was not toxic for the concentration level of test. In the paper (Wang, 1999) the authors investigated the effects of vanadium V^{5+} on the growth of soybean seedlings in two soils grown in the pots in glasshouse. They observed the symptom of vanadium toxicity appearing in the case of plants grown on fluvo-aquic soil. Addition of vanadium in six lakes, in different concentrations decreases photosynthetic rates of phytoplankton (Nalewajko, 1995). Another aspects on vanadium effects with different concentrations are presented in (Fargasova, 1999), (Olness, 2000), (Abu-Seidah, 1995), (Frajnt, 2002). In general, it is accepted that the toxicity of vanadium compounds is low. Pentavalent compounds are the most toxic and the toxicity of vanadium compounds usually increases as the valence increases (Barceloux, 1999). In his paper, K.H.Thompson (Thompson, 1999) summarizes current knowledge of the bioinorganic chemistry of vanadium, and the in vitro and in vivo effects of both inorganic and organically-chelated vanadium compounds, especially in medicine. The effect of the vanadium salts treatment on growth and photosynthesis for pepper plants (*Capsicum anuum*) is presented in this work. This specie was chosen because the pepper is one of the most widely cultivated vegetables in Romania.

MATERIAL AND METHOD

Research was carried out at the University of Agronomy and Veterinary Medicine Iasi. Twenty pepper seeds, were planted in the greenhouse of the University. After germination, seedlings were thinned one per pot and the plants were grown in optimal conditions. Concomitantly we prepared a 1% solution containing V^{3+}, V^{4+} and V^{5+}, namely: $V_2(SO_4)_3$, $VOSO_4*H_2$ and $Na_3VO_4*14\ H_2O$. But it is known that $V_2(SO_4)_3$ hydrolyses obtaining a strongly acid solution and it cannot be used to treat the plant. Moreover V^{3+} is believed to oxidize to V^{4+} or V^{5+} under physiological conditions but these transformations were not well studied. After that we treated the pepper plants separately with vanadium compounds, variants in study being the following:

1-control;

2- $VOSO_4*H_2O$- vanadyl sulfate (V^{4+});

3- $Na_3VO_4*14\ H_2O$- sodium orthovanadate (V^{5+})

For pigment analysis, 0.5 g of fresh leaf tissue were measured and the leaves were cut into small pieces (about 1 mm wide). The pigments were extracted by grinding in a mortar and pestle for 5 minutes. The extract was filtered and transferred to 50ml acetone. Absorbtion spectra were measured using a spectrophotometer SPECORD 200 from Analytik Iena immediately after the preparation of the solutions. All measurements for the pigment content were performed at the same phenological stage, so that the comparison was made on leaves in the same nodal position

(Oancea, 2005). Pigment content has been calculated according to Lichtenthaler formula (Oancea, 2007).

RESULTS AND DISCUSSIONS

In this experiment 20ml solution were poured into the soil at the root of each plant during two weeks. The plants treated with V^{5+} have been strongly affected (the leave necrosis began) as figure 1 shows. This is the reason that the experiments followed only for control and treatment with V^{4+}.

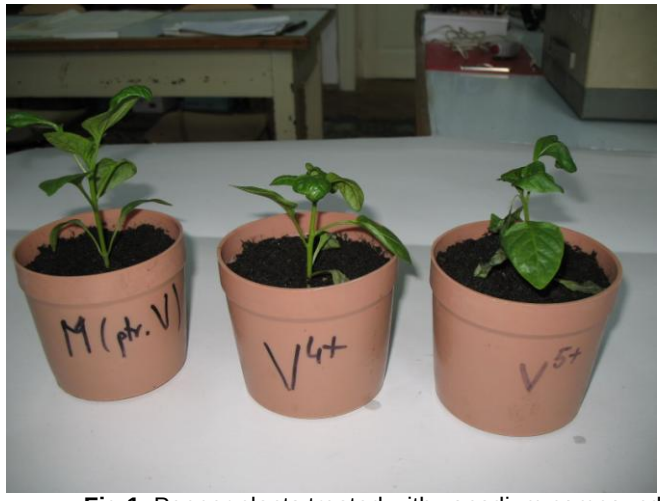

Fig.1. Pepper plants treated with vanadium compounds

The absorbtion spectrum of the photosynthetic pigments is presented in figure 2.

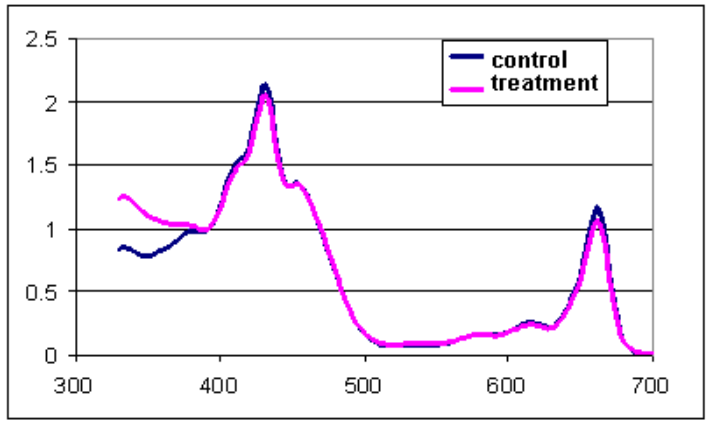

Fig.2. Absorbtion spectrum of the photosynthetic pigments from pepper leaves

The content of the photosynthetic pigments, chlorophyll a (Chla) and clorophyll b (Chlb) from pepper leaves are given in figure 3

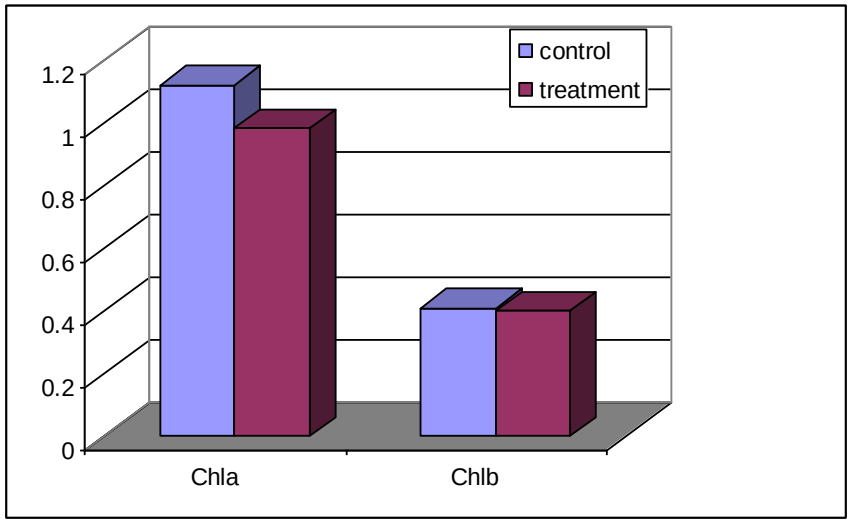

Fig.3. The content of chlorophyll a and chlorophyll b, mg/g fresh tissue, from pepper leaves

From figure 3 we can see that we obtained a diference for chlorophyll a but for chlorophyll b the results show aproximatively the same values for control and treatment variant. Therefore for the total content of clorophylls, which is shown in figure 4, a diference exist between control and the treatment variant.

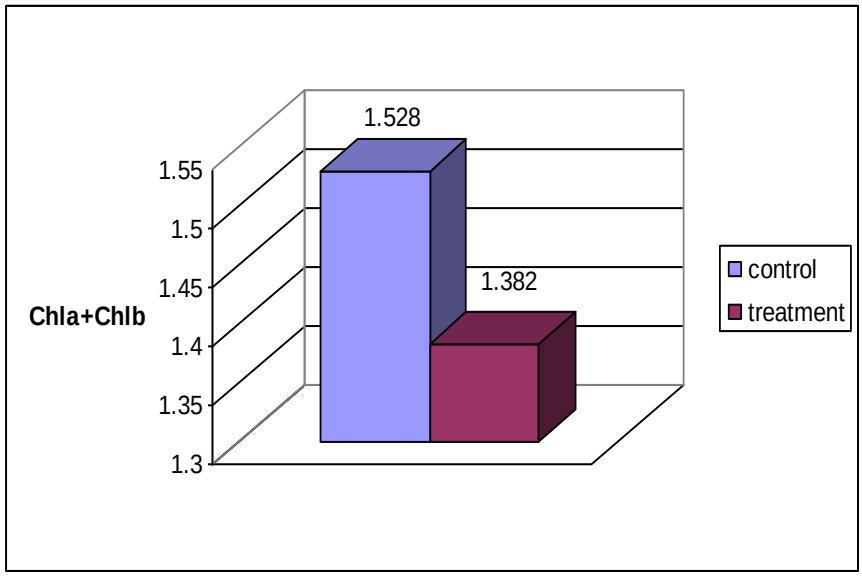

Fig.4. The total content Chl a+Chl b , mg/g fresh tissue, from pepper leaves

Due to a increases of the pigment content which have de maximum of absobtion for small wavelenght, the ratio Chla/Chlb decreases from control to treated variant as figure 5 shows.

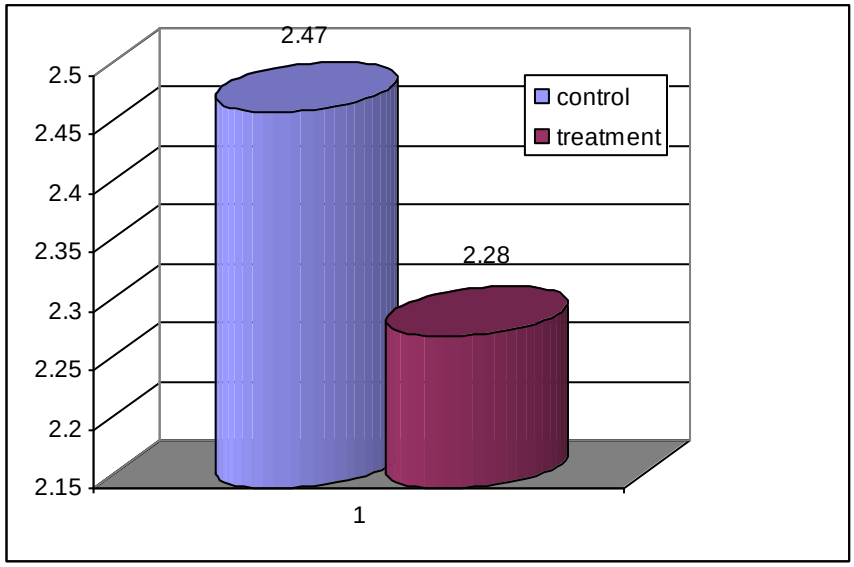

Fig.5. Ratio Chla/Chlb from pepper leaves

In fig 1, 2, 3, 4 and 5 it is shown that the chemical treatment induces modifications to the content of photosynthetic pigment in pepper leaves. Plants treated with vanadium compounds as compared with the control presented less photosynthetic activity. The reduction in the Chl a observed in the leaves of the treated plants confirms the phenomenon that chlorophyll accumulation in pepper plants can be disturbed when plants are treated with vanadium compounds.

The ratio Chl a/Chlb presented in fig. 5 shows that, both for control and for treatment this ratio is decreased than the usual value of 3, but is smaller for treatment than the control one.

CONCLUSIONS

The effect of vanadium compounds on the photosynthetic activity pf the pepper plants has been analyzed in this work. It is confirmed that the toxicity of vanadium compounds is low and the toxicity of vanadium compounds increases as the valence increases. Our results are concordant with those presented by Fargasova (Fargasova, 2000), which studied the seedlings of *Sinapis alba* which were grown in the presence of five trace metals. Metal ions Mn, V and Cu decreased in comparison with the control production of chlorophyll a, chlorophyll b and carotenoids.

As in any organism, plant tolerance to stress is determined by the functional integration of many individual traits and adaptation. Such possibilities may explain why some studies have demonstrated a relationship between treatment with vanadium compounds and other did not. Although the relationship between cellular plants and stress is not known, this study reveals that pepper are sensible

to stress produced by vanadium compounds. We can conclude that vanadium effects on plant growth are important and we will keep analyzing its effects on other studies that we will carry out.

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