Scientific Bulletin. Series F. Biotechnologies, Vol. XXI, 2017

EFFECT OF EXOGENOUS ABSCISIC ACID ON SOME QUALITY ATRIBUTES OF SWEET POTATO (*Ipomoea batatas* L.)

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Abstract

*Sweet potato (*Ipomoea batatas* L.) is an important food crop around the world, being cultivated in more than 100 countries as the crop can be a rich source of energy and have been recognized as healthy foods because of their significant content of phytonutrients. In recent years, the use of bioregulators in sustainable agriculture has been growing because it leads to higher content of nutrients in the plant tissues and positive metabolic changes. It appears that using abscisic acid in controlling the mechanisms of plant evolution is a good alternative for an ecologic agriculture given that recent studies on the mechanism of the abscisic acid action have shown its great importance as a bioregulator for plants. The objective of this work was to to study the influence of the abscisic acid treatment on some quality characteristics of sweet potato. For this purpose abscisic acid solutions in different concentrations were used as foliar treatments on sweet potato leaves and comparative results concerning some morphological and biochemical changes in the tuberous roots were studied. The experiment was conducted starting with the first leaves appearance until the harvesting of the roots, while determination of the sugars and proteins content were made on the tuberous root harvested in the maturity stage.*

Key words: *abscisic acid, phytohormones, proteins, sugars, sweet potato.*

INTRODUCTION

Sweet potato (*Ipomoea batatas* L.) is an important food crop around the world, being cultivated in more than 100 countries (Wu et al., 2008). The crop can be a rich source of energy as well as of carbohydrates. The carbohydrates concentration in sweet potato roots varies widely between individual lines (Hill et al., 1992). Despite the high carbohydrate content, sweet potato has a low glycemic index, indicating low digestibility of the starch (ILSI, 2008) and it is the only starchy staple, which contains appreciable amounts of amino acid lysine that is deficient in cereal-based diets like rice (Bradbury et al., 1985). Also, orange-fleshed cultivars have been recognized as healthy foods because of their significant content of phytonutrients, such as β-carotene, anthocyanin (Mohamad-Zahari, 2016), phenolic acids, minerals, vitamins and dietary fibre (Turner, 2001; Tumuhimbise et al., 2009).
An important reason for the popularity of sweet potato is its adaptability to a range of agroecological conditions (Horton, 1988).
In recent years, the use of bioregulators in sustainable agriculture has been growing. The application of bioregulators leads to higher content of nutrients in the plant tissues and positive metabolic changes.
The mode of action of bioregulators is often unknown and difficult to clarify because they contain multiple bioactive components, for instance plant hormones, that together may contribute to specific effects in plants (Ertan et al., 2011).
It appears that using abscisic acid in controlling the mechanisms of plant evolution is a good alternative for an ecologic agriculture given that recent studies on the mechanism of the abscisic acid action have shown its great importance as a bioregulator for plants.
Besides environmental factors (water, nutritive substances, temperature, light) phytohormones play an essential role in controlling the plant growth, cells differentiation and development. Phytohormones are a group of naturally occurring, organic substances which influence physiological processes at low concentrations (Davies, 1987).
The main hormonal groups acting in the plant tissues are auxins, gibberellins, citokinine, which are considered growth promoters,

together with abscisic acid and ethylene, known as growth inhibitors. However, it is interesting to note that hormones do not act alone, such as the final effect on the plant development is the result of a hormonal balance, which controlls many processes that impact on crop performance and yield (Wilkinson et al., 2012).

Phytohormones with inhibitory properties can operate on the whole plant as well as on some tissues and organs causing the inhibition of some metabolic processes like: biosynthesis of nucleic acids, photosynthesis of chloroplasts and of some physiological processes, especially the division and elongation of cells and the buds opening (Davies, 1987).

Abscisic acid (ABA) is often referred to as a inhibitory rather than stimulatory hormone. ABA accelerates the process of ageing and the fruit and leaves abscission by causing break down of proteins and nucleic acids. It is involved in the closure of stomata, bud and seed dormancy, response to drought stress (Bassaganya-Riera, 2010) and is known to inhibit other hormonal actions.

The objective of this work was to study the influence of the abscisic acid treatment on some quality characteristics of sweet potato. For this purpose solutions of abscisic acid in different concentrations were used as foliar treatments on sweet potato leaves and comparative results concerning some morphological and biochemical changes in the tuberous roots were studied. The experiment was conducted starting with the first leaves appearance until the harvesting of the roots, while determination of the sugars and proteins content were made on the tuberous root harvested in the maturity stage.

MATERIALS AND METHODS

Biological materials

Sweet potato (*Ipomoea batatas* L.) Porto-Rico variety, a common variety largely spread in countries where sweet potatoes is traditionally consumed, was investigated. Bush-type Porto Rico is an ideal variety for smaller gardens, which also produces good yields of medium-sized potatoes with tapered roots that are great for baking because the delicious sweet flavor of the orange flesh.

The experiment was conducted starting with the first leaves appearance until the harvesting of the tuberous roots (meaning for 6 months, from May to October). During the experiment development the sweet potatoes plants were treated with solutions of 10^{-5} mol/L, $1.5x10^{-5}$ mol/L, $2x10^{-5}$ mol/L and $3x10^{-5}$ mol/L ABA by foliar applications once every two weeks, according to horticultural practice (Ifrim, 1997).

Determination of the sugars and proteins content were made on the tuberous root harvested in the maturity stage. The biochemical analyzes were made in triplicate, using fresh tuberous roots of sweet potatoes.

Determination of reducing sugars was performed according to the Nelson-Somogyi method (Iordachescu, 1988; Somogyi, 1952). The reducing glucids when heated with alkaline copper tartrate reduce the copper from the cupric to cuprous state and thus cuprous oxide is formed. When cuprous oxide is treated with arsenomolybdic acid, the reduction of molybdic acid to molybdenum blue takes place. The measurements of absorbance were achieved at 620 nm with a UV/Visible ThermoSpectronic Helios spectrophotometer.

Determination of crude protein was made after the digestion of the vegetal material by Kjeldahl method (Iordachescu, 1988; Kjeldahl, 1883). The content in total nitrogen was measured by volumetrical method and converted in crude protein content.

RESULTS AND DISCUSSIONS

The molecular action mechanism of ABA in plants is not fully elucidated. It is known that ABA has a biochemical and physiological action against substances that stimulate growth, resulting in a biochemical balance that causes the growth and development of the plant in different phenophases and seasons.

The objective of this work was to study the influence of the abscisic acid treatment on some quality characteristics of sweet potato. For this purpose solutions of abscisic acid in concentrations of 10^{-5} mol/L, $1.5x10^{-5}$ mol/L, $2x10^{-5}$ mol/L and $3x10^{-5}$ mol/L ABA were used as foliar treatments on sweet potato leaves followed by observations on some morphological characteristics of the plants and also by determination of the sugars and proteins content of the tuberous root harvested in the maturity stage.

Influence of ABA on some morphological characteristics

Leaf area is a plant biometric index important to crop production. It was found that foliar treatment of sweet potato plants with ABA induced changes in the leaf aspect. Thus, the leaves were smaller and irregular shaped (figure 1B) at the plants treated with concentrations of 10^{-5} mol/L, $1.5x10^{-5}$ mol/L and $2x10^{-5}$ mol/L ABA compare to the leaves of the control plants, which were wide, large and smooth (figure 1A).

On the contrary, the $3x10^{-5}$ mol/L concentration of ABA induced a total inhibition of the plants growth and development, so that the plants died after one month of ABA treatment.

Thus, ABA in concentrations of 0.01, 0.1, 1.0 or 10.0 mg 1^{-1} inhibited axillary bud and root development at the sweet potatoes plant and subsequent plantlet growth. ABA at 10 mg 1^{-1} completely inhibited axillary shoot development but did not affect the viability of the plants (Jarret, R.L. et al., 1991). Researches made on bell pepper found that plant stem diameter was lowest in ABA treatment; marketable yield was highest in ABA (Díaz-Pérez et al., 2014).

Instead, regarding the tuberous roots it was noticed an increase in size and number as results of the treatment with 10^{-5} mol/L ABA (figure 2B) compare to the control plants (figure 2A).

A)

B)

Figure 1. Aspect of the leaves of control plants (A) compare to plants treated with 10^{-5} mol/L ABA solution (B)

A)

B)

Figure 2. Aspect of the tuberous roots of control plants (A) compare to plants treated with 10^{-5} mol/L ABA solution (B)

Previous studies reported also that treatment with abscisic acid influenced the plant growth.

Considering that hormones have been suggested to play a prominent role in the control of tuberization, it was assumed that

ABA is a promoting hormone in potato tuberization. Scientific literature reports that exogenous ABA stimulated tuberization and reduced stolon length in potatoes (Xu et al., 1998).

Influence of ABA on some biochemical parameters

The soluble sugar is the main substance for plant growth and fruit quality formation. It has been demonstrated that sugar accumulation in sink organs (flowers, fruits, roots etc.) is stimulated by application of some plant hormones including ABA (Brenner et al., 1989; Daie, 1985).

The treatment with ABA of the sweet potato plants determined an increase of the sugars content together with a decrease in the protein content at the plants treated with concentrations of 10^{-5} mol/L, $1.5x10^{-5}$ mol/L and $2x10^{-5}$ mol/L ABA (Figure 3), indicating a change in the photosynthesis development in the plant leaves. It is known that photosynthetically active tissues, such as mature leaves, export fixed C (primarily as sucrose) to non-photosynthetic tissues such as fruits or reproductive organs, tubers, meristems, roots (Koch, 2004).

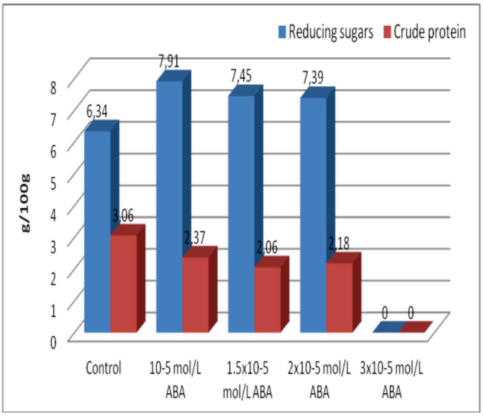

Figure 3. Influence of the ABA treatment on the content in reducing sugars and crude protein of the tuberous roots

Previous studies have found an increase in sugar content of the root of bean seedlings which appears to be the consequence of an ABA-induced stimulation of sugar transport from the shoot to the root (Karmoker and Van Steveninck, 1979).

Similar results are noticed in recent papers concluding that an exogenous ABA treatment increased sugar content also in other plant species as *Citrus* fruit (Kojima et al., 1996) and peaches (Kobashi et al., 2001).

CONCLUSIONS

It was found that foliar treatments of sweet potato plants with 10^{-5} mol/L ABA induced changes in the leaf aspect: smaller and irregular shaped at the plants treated with ABA compare to the leaves of the control.

Regarding the tuberous roots it was noticed an increase in size and number as results of the treatment with 10^{-5} mol/L ABA compare to the control plants. Considering that hormones have been suggested to play a prominent role in the control of tuberization, it was assumed that ABA is a promoting hormone in potato tuberization.

The $3x10^{-5}$ mol/L concentration of ABA induced a total inhibition of the plants growth and development.

The treatments with ABA of the sweet potato plants determined an increase of the sugars content together with a decrease in the protein content indicating a change in the photosynthesis development in the plant leaves.

It appears that using abscisic acid in controlling the mechanisms of plant growth is a good alternative for an ecologic agriculture given that recent studies on the mechanism of the abscisic acid action have shown its great importance as a bioregulator for plants.

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