Effectiveness of growth regulators, based on the heterylcarbon acid, on forcing of Tulips (Tulips HD)

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Abstract. The main factor in growing flowers for forcing is their rate of growth, on account of the fact that in short period of time it is necessary to grow quickly a large number of flowers and to cut them simultaneously.

The influence of growth regulators (GR) based on heterylcarbon acid on the forcing of tulips in greenhouse conditions (winter period) was studied. It was determined that the application of GR_1 of the basic within tulip's forcing period reduces in average to 5 days (from all period of forcing). In case of application GR_2 the tulip's forcing period also reduces to 3 days (from all period of forcing) compared with a control group of tulips. The ability of the plant growth regulators under research to accelerate growing properties of flowers is associated with the presence of heterylcarbon acid and potassium ions in their structure of substances. These growth regulators relate to non-toxic compounds and possess antioxidant properties.

Keywords: growth regulators, heterylcarbon acid, forcing of tulips, antioxidant activity.

Introduction

Popular plant growth regulators are largely related to derivatives of carboksylcontaining compounds. These are gibberellins – the substances which also apply to organic acids and have a strong effect on plant growth and accumulation of dry weight.

Gibberellins are good to be used for sprouting seeds, as they can awake plants. Some plants, like tulips, if they need to bloom ones for a while must stay at a low temperature, or at light or short days, or sometimes both. Treating such plants with gibberellinic acid, they can be made to bloom in the conditions in which only vegetative growth is possible [6].

Gibberellins – a biologically active substance which is responsible for the development of the stem. Gibberellins speed up flowering of many plants [10]. Extensive gibberellins are widely used in decorative gardening.

Gibberellin A3 – gibberellinic acid has the greatest physiological activity. Because of the extreme complexity of the molecule structure chemical synthesis become hard to overcome. Besides gibberellins, Streptomycetes in their lifetime form substances of a different chemical nature having significant stimulating effect on plants [3].

According to modern concepts plant growth regulators are natural and synthetic organic compounds of significant biological activity having in small portions alter physiological and biochemical process, growth, development and yield formation of agricultural plants without causing a toxic effect. In this regard, our attention was drawn by previously unexplored S-heterylderivatives tioacid and their derivatives [7]. Among them are environmentally friendly substances which at low consumption rates are fungicidally, bactericidally and growth stimulating highly active [8]. Basing on these compounds and their compositions with natural biostimulants a number of efficient, low-cost, environmentally friendly technologies GR and their use for most crops was developed.

Heteryltiocarbon acids derivatives are known for it different kinds of biological effect and also known as stimulators of plant growth, such as dihydrochloride S-(pyridin-4-yl) – L-cysteine and it is a slightly toxic compound that has a strong growth stimulating activity and recommended for further research as growth stimulating substance capable of increasing the length of the main root and the number of lateral roots sprouts of plants of Cucurbitaceous family, which promotes faster development of hypocotyls and leaves, which in turn increases productivity and viability of plants [9].

The purpose of this study is to examine the effects of other derivatives (potassium salts) among this class of organic acids on their use as plant growth regulators, which also speeds up both the stems growth and flowering.

According to purpose was given the following tasks: determine the effect of substances on the growth rate of tulips; determine the antioxidant activity of substances; determine substances safety (Medium lethal dose (LD_{50})).

Materials and methods

The subject of the research was tulips (tulipa HD) (grade “forgotten dreams”), the bulbs of tulips were prepared according to the process of forcing in greenhouse conditions. The tulips forcing was during winter.

Watering tulips was with appropriate regularity, using growth regulators. Control plants were only watered. The study applied growth regulators which were created on the heterylcarbon acids (GR_1 – derivative dicarboxylic acid, GR_2 – derivative monocarboxylic acid).

After planting 5 research groups (rows) were formed by 10 plants in each group. The first group was the control of tulips; they were watered only with water.

Other 4 groups were watered with solutions of growth regulators: II group – GR_1 in concentration of 1 ml/L; III group – GR_1 at the concentration of 10 ml/L; IV group – gibberellins at the concentration of 10 ml/L (standard plant growth regulator); V group – GR_2 at the concentration of 10 ml/L.

To determine the effect of these substances on the growth, development and quality of flowers conventional methods (weighing, measuring, determining the proportion of growth) were used. Studies of the acute toxicity of quinoline derivatives were defined on outbreed mice of both intact families weighing 16-24 g (4 groups) and outbreed mice were injected intraperitoneally the solution substances of volume less than 1 ml. The control group of animals was injected with saline and Tween 80 in the same volume as the study group. Each group consisted of 5 animals. Medium lethal dose (LD_{50}) was determined by the Kerber's method [5].

LD_{50} conducted by Kerber's formula (1):

$$\lg LD_{50} = \lg D_N - \delta \times \left(\sum L_i - 0{,}5\right), \quad (1)$$

where D_N – maximum dose toxin, (ml);

δ – decimal logarithm multiplicity dilutions;

L_i – attitude number animals dead from administration this dose to a common number animals which it was introduced this dose.

Definition the antioxidant activity (AOA) of substances in the experiments was conducted on the model of inhibition of superoxide radical. As a reference material a certain antioxidant, is used – emoksypin. It is similar by structure with our substances. This valuation method AOA *in vitro* enables evaluation of free radical (FR) process oxidation at initial stages. FR-processes were caused by means of the reaction of adrenaline autooxidation into adrenochrome in alkaline medium, which leading to the formation of oxygen active form – superoxide radical [1].

Results and Discussion

We synthesized two substances from heterylcarbon acids and investigated them as plant growth regulators, apart from tulips in the winter to fasten their forcing in greenhouse.

Cooling is necessary to regulate the growth of tulips. At this time the plant accumulates gibberellins. During the whole period of cooling and rooting of bulbs we supported high humidity of substrate and air indoors.

Cooling period lasted 17 weeks. During this time the bulbs had rooted and given in the control row a strong sprout in average of 5 cm high for this group, and in the experimental row II in average of 7,5 cm for this group. The rooting temperature varied 7-9 °C.

In mid-January the temperature was increased to 16-18 °C. By this time the shoots in the experimental row reach II – 10 cm and in the control row – in average of 6,5 cm.

After 7 days, the temperature was raised to 18-20 °C. The sprouts by that time have reached 9,85 cm in the control row in average, in the experimental row II – 13,93 cm, in the experimental row III – 10,60 cm in average, in the experimental row IV – 10,20 cm in average, in the experimental row V – 12,85 cm in average. That is in average the growth of sprouts in the second experimental row was 4,08 cm higher in comparison with the control row. After 7 days (early February) appeared first buds in the second experimental rows, and after next 5 days buds started to appear in other research groups. The best result in 3 period of growth was in II row, the height of tulips in average in this row was 42 cm (Fig. 1).

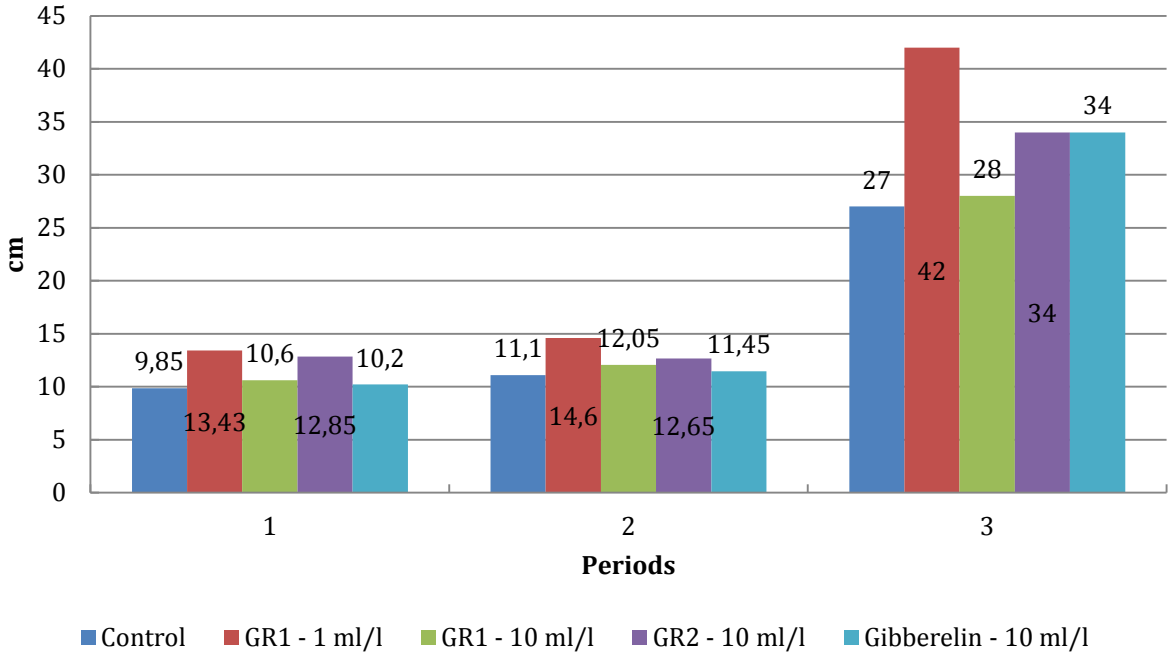

Figure 1 – Dynamics of tulips growth during forcing

Periods: 1 – at the time of deploying the second or third leaf in shoots of tulips; 2 – at the time before flowering; 3 – at the time of flowering.

After the buds colored the temperature was lowered to 14-15 °C to prolong the period of flowering tulips, besides the flowers were stronger and brighter colors. After 7 days more, the flowering process went on consistently in all groups.

Discussion

Effective, low-cost (compared to giberillins), environmentally friendly technologies *GR* and their application to plants were developed. It was established that growth regulators based on heterylcarbon acids increase membrane permeability, active and passive transport of substances, accelerate the process of transcription, intensify protein synthesis in the cell, possess antioxidant activity and thus the growth and development of flowers accelerates.

The obtained results suggest that the rate of forcing tulips in greenhouse on condition of using growth regulator obtained from heterylcarbon acids gives it more stable and faster results compared to forcing tulips when watered.

Because of possible toxic effects of growth regulators on vertebrate organisms (primarily human) we studied the acute toxicity on mice. To study the potential mechanism of the effect of the created bioregulators we investigated their antioxidant activity in vitro (Fig. 2).

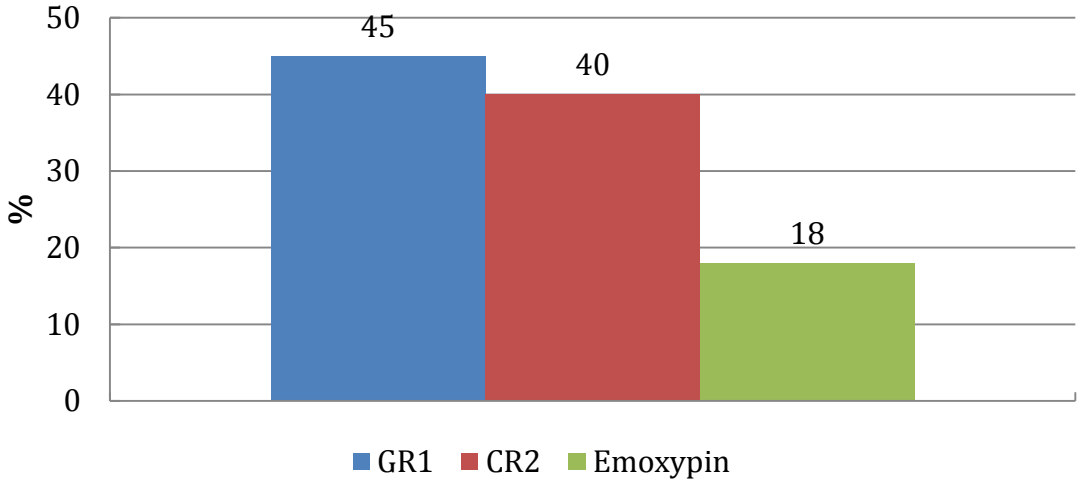

Figure 2 – Comparing the antioxidant activity of substances

AOA, primarily, is determined by the nature of the functional groups in the carboxylic acid residue – GR_1 by activity is slightly superior to GR_2 and reference antioxidant. The substances tested are promising in terms of creating tsytoprotectors with antioxidant mechanism of action.

It is known that reaction of an organism to alien substances depends on their chemical structure. It was set naturally the potential toxicity of growth regulators on experimental animals (mice) due to the influence of substances on Mammals. As the result of experimental studies the acute toxicity of heterylderivatives was investigated. The test results show that regulators LD_{50} is more than 1000 mg/kg, which allowed refer them to virtually non toxic substances (V class of toxicity from V classes) [11].

Conclusions

Index growth of flowers rate is of great significance. This index was a major factor in order to use the new growth regulators to speed up coming of tulips. The experiment showed that growth regulator used in the second experimental group is more effective compared to other growth regulators. As a result, growth regulator GR_1 at a concentration of 1 ml/L is more efficient compared with referents-matter – gibberellins and other studied growth regulators. GR_2 also showed itself well and was effective for forcing tulips, with its usage the sprouts growth was somewhat slower compared to GR_1, but flowering tulips was stable and simultaneous.

Created growth regulators based on heterylcarbon acids are practically non-toxic (V class of toxicity). Synthesis of our compounds is much simpler and less expensive in relation to the cost of gibberellin.

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Эффективность регуляторов роста на основе гетерилкарбоновых кислот на выгонку тюльпанов

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Аннотация. Основным фактором при выращивании цветов на выгонку является скорость их роста, в связи с тем, что за короткое время нужно быстро вырастить большое количество цветов и одновременно их срезать.

Исследовано влияние регуляторов роста (GR), созданных на основе гетерилкарбоновых кислот, на выгонку тюльпанов в тепличных условиях (зимний период). Определено, что при применении GR_1 основной период выгонки тюльпанов сокращается в среднем на 5 дней. При условии применения GR_2 период выгонки тюльпанов также сокращается на 3 дня (по сравнению с контрольной группой тюльпанов). По результатам исследования скорости роста растений доказано, что ускоряющие свойства регуляторов роста растений обусловлены наличием ионов гетерилкарбоновой кислоты и калия в их составе. Эти регуляторы роста относятся к нетоксичным соединениям и обладают антиоксидантными свойствами.

Ключевые слова: регуляторы роста, гетерилкарбоновая кислота, выгонка тюльпанов, антиоксидантная активность.