EFFECT OF SALICYLIC ACID´S DERIVATES ON PLANT GROWTH AND PRODUCTIVITY

EFECTUL UNOR DERIVAŢI AI ACIDULUI SALICILIC ASUPRA CREŞTERII ŞI PRODUCTIVITĂŢII PLANTELOR

ŞTEFÎRŢĂ Anastasia[1], TOMA S.[1], BARBĂ N.[1], BRÂNZĂ Lilia[1], ROBU Ş.[1], MELENCIUC M.[1], BUCEACEAIA Svetlana[1]
e-mail: anastasia.stefirta@gmail.com

Abstract. *It has been studying the effect of salicylic acid's derivates, in particular of ammonium- and potassium- tioureidosalicilates in combination with bioactive polyvinylpyrrolidone co-polymer on growth and development processes of cucumber, potatoes, corn plants targeting possibility to stabilize / increase the production process, in laboratory, green house and field conditions experiments, during several years. The administration of compounds (by seeds and foliar surface treatments) makes the consumption to be more economical and the use of soil water reserves more productive by increasing water retention capacity in tissues, activation of the biosynthesis and phytobiomass accumulation, which ensure the formation of more vigorous plants with higher productivity. It was established the compatibility of salicylic acid's derivates with the chemical protective substances against diseases and pathogens, which provides economic advantages and environmental safety of the plant cultivation technology and enables to reduce of the labour and anthropogenic costs.*

Key words: ammonium- and potassium- tioureidosalicylates, polyvinylpyrrolidone co-polymer, plant growth, productivity.

Rezumat. *În experienţele realizate în condiţii de câmp pe parcursul a mai multor ani, a fost studiat efectul unor derivaţi ai acidului salicilic (în particular al tioureidosalicilaţilor de amoniu şi potasiu, în combinaţie cu co-polimerul bioactiv polivinilpirolidon) asupra proceselor de creştere şi dezvoltare a plantelor de castraveţi, cartof, porumb, vizând posibilitatea stabilizării / majorării procesului de producţie. Administrarea preparatului (prin tratarea seminţelor şi aparatului foliar) condiţionează consumul mai economic şi utilizarea mai productivă a rezervelor de apă din sol prin majorarea capacităţii de reţinere a apei în ţesuturi, activarea biosintezei şi acumularea fitomasei, ceea ce asigură formarea unor plante mai viguroase cu o productivitate ridicată. S-a stabilit compatibilitatea preparatelor cu substanţele de protecţie chimică contra dăunătorilor şi a patogenilor, ceea ce asigură rentabilitatea economică şi siguranţa ecologică a tehnologiei de cultivare a plantelor şi permite reducerea costurilor de producţie.*

Cuvinte cheie: tioureidosalicilaţi de amoniu şi potasiu, co-polimer polivinilpirolidon/ metacrilat, creştere, productivitate.

[1]Institute of Genetics and Plant Physiology of ASM, Republic of Moldova

INTRODUCTION

Due to the increased frequency of droughty time the problem of increasing resistance to drought of the most important agricultural crops is treated more and more in last years. An important opportunity, and still not exploited, to increase productivity of crops, is considered the use of physiologically active substances (PAS) and also of anti-transpiration substances (ATS), which provides the increasing of adaptive properties of the organism in suboptimal environmental conditions. Currently, the scientific literature accumulates more and more information about the indispensable role of phytohormones, in particular, of salicylic acid (SA), in response reaction of plants to the stress factors' action from the external environment. It is considered (Raskin I., 1992; Shakirova F.M. et. al., 2003; Ştefîrţă A. et al., 2006) that an important compound of the mechanism of SA's protective action is to prevent the stress induced disturbance of the phytohormones' balance. It occurs primarily by indolil acetic acid (IAA) accumulation – a plant hormone that regulates growth and secondly, by inducing ABA synthesis – plant hormone that activates antistress programs. In the present study it was investigated the effect of SA compounds with NH_4^+, K^+ and its derivates in combination with bioactive co-polymers (co-VP) as well as with chemical protective substances (Confidor, Dithane M45) on water status parameters, plant growth and productivity.

MATERIAL AND METHOD

In present research plants of *Cucumis sativus* L., Concurent and Mirabella varieties and Rodnicioc F1 and Icar F1 hybrids, *Lycopersicon esculentum* L. Lider cultivar (cv), and Madona, of *Solanum tuberosum* L, Finca, Bellarosa and Carolla varieties, served as object of study. The experiments were set up in the experimental fields of the State Center for Plants' Varieties Testing in Bacioi using block method, in 3 replications with randomized location of variants. Plants grown under agricultural technology served as control. Treatments of seeds and tubers before sowing / planting and of foliar apparatus, were performed in the experimental variants, during the vegetative growth with aqueous solutions of salicylic acid, salicylates of NH_4^+, K^+, potassium and ammonium 5-tioureidosalicylates in combination with bioactive co-polymers (co-VP), as well as with chemical protective substances (Confidor, Dithane M45).

The range of physiological optimal concentrations has been established in special laboratory investigations (Ştefîrţă A. et al., brevet de invenţie MD 3438 G2 2007 12.31; MD 3466 G2 2008.01.31).

The estimation of adaptive reactions was performed by plant height, biomass, leaf area, productivity and yield structure determination. The results were statistically analyzed using the software package for computers "Statistica 7".

RESULTS AND DISCUSSIONS

There are typical suboptimal, constant or recurring conditions, most often of climate provenance (moisture deficit, heat, cold, salinity etc.), characteristic for vegetable growing areas, during the plant active vegetation period. The action of unfavorable environmental conditions considerably reduces yield and its quality.

Testing the effect of ATS on the formation of plant productivity elements and agricultural valuable part of production revealed the positive, beneficial, veridical action of the water-soluble polymer polyvinylpyrrolidone (PVP) and potassium and ammonium methacrylate vinylpyrrolidone co-polymers (coVPK, coVPNH$_4$) on plant growth, development and yield (table 1).

Table 1

The influence of water-soluble polymers on *Cucumis sativus* L., Icar cv. plants productivity

Variant	Number of fruits, un · pl.$^{-1}$	The average weight of 1 fruit, g	Production, g · pl.$^{-1}$	The yield, kg · m^2	The efficiency, % control
Control, H_2O	6,0 ± 0,07	72,0 ± 1,6	432,1 ± 12,5	3,9 ± 0,1	100
PVP	6,7 ± 0,14	70,0 ± 1,4	470,2 ± 15,3	4,2 ± 0,1	108,5
coVPK	7,4 ± 0,08	70,4 ± 0,8	518,8 ± 11,2	4,7 ± 0,1	119,7
coVPNH$_4$	7,2 ± 0,19	69,9 ± 1,2	503,9 ± 11,6	4,5 ± 0,1	113,7

Thus, the plant treatments with 0.05% PVP aqueous solution provided a production increase of 8.5 percent, the application of coVPNH$_4$ and coVPK increased crop from 13.7 to 19.7% compared to the size of control plants' crop. Using water-soluble polymer films contribute to early fructification and getting early vegetable production. It was established that the application of water-soluble polymer PVP has led to increased plant fructification dynamic in the I-IIIrd decade of July with 10% from control and with 13.87% more for plants in the "coVPNH$_4$" variant. Size of early production of plants treated with "coVPK" exceeded the value of "control" plants' crop with 20.95% and 9.3% compared with the same time harvest of the plants treated with PVP.

Growth, development and productivity of plants, including vegetables, may be regulated by a combination of substances containing orthooxybenzoic acid as growth stimulator. It was established a positive, statistically authentic influence of the plant treatment with biologically active substances (BAS): aqueous solutions of ammonium and potassium salicylates, on biological performances (table 2).

Table 2

The BAS influence on productivity and yield of vegetable plants grown in open field

Variant	Number of fruits, unit pl.$^{-1}$	The average weight of 1 fruit, g	Production, g · pl.$^{-1}$	The yield, kg · m^2	The efficiency, % control
Cucumis sativus L., cv. Icar					
Control, H_2O	5,1 ± 0,17	52,8 ± 1,22	269,0 ± 10,6	2,42 ± 0,11	100,00
salicylates+PVP	6,9 ± 0,24	61,6± 0,47	424,9± 15,1	3,83 ± 0,15	158,0
Lycopersicon esculentum L., cv. Madona					
Control, H_2O	6,1± 0,22	62,1 ± 1,52	378,5 ± 14,8	5,68 ± 0,15	100,00
salicylates+PVP	16,2 ± 0,43	67,1 ± 1,85	1088,2 ± 31,4	16,32 ± 0,31	287,4

Salicylates provided an increased yield of cucumbers with 58.0 percents compared to the control. Similar data have been recorded for tomatoes, too, for Leana and Madonna varieties the treatment resulted in significant production surplus.

It is known that ortho-oxy-benzoic acid compounds (SA) with sulfur have properties to regulate plant growth and tolerance to abiotic and biotic factors of the external environment. In order to explore an integrated process of yield increasing and complex resistance of plants it was followed the influence of salicylic acid and sulfur derivatives (5-tioureidosalicylates), used in combination with water-soluble polymers coVPNH_4 and coVPK on plant growth and development. Results are presented in table 3. Obtained experimental data argue authentically the used substances' proprieties to stimulate growth and primary productivity formation of plants. The major influence ensures seed treatment with the 5-TUS-NH_4 solution of 0.0001 and 0.0005% concentration. It was recorded an intensification of growth processes in these variants, with 39.6 and 52.3 percents higher compared with control plants. It was noted a positive effect of 5-TUS-NH_4 on cucumber plants' productivity, in the field experience (table 3).

Table 3

The influence of BAS on crop productivity and yield structure of cucumber plants, Icar cv.

Variant	Number of fruits, unit · pl.$^{-1}$	The average weight of 1 fruit, g	Production, g · pl.$^{-1}$	The yield, kg · m^2	The efficiency, % control
Control	6,4 ± 0,13	68,8 ± 0,85	440,3 ± 12,1	3,96 ± 0,12	100,0
SA	6,8 ± 0,11	67,9 ± 0,56	461,7 ± 10,8	4,16 ± 0,11	105,1
5-TUS-NH_4	7,7 ± 0,19	67,2 ± 0,62	517,4 ± 14,3	4,66 ± 0,14	117,7

As mentioned above, the shortage of soil water inhibits plant growth and primary productivity, and the agronomic value part also is linearly dependent on the saturation deficit of organs. A widely accepted way to increase resistance to drought is considered the possibility of increasing water use efficiency by the application of PAS. Moreover, the efficiency of water use is estimated as a component of drought tolerance in natural systems and is considered as an alternative way to increase it (Jones H.G., 1993). The data obtained by us (fig. 1) in experiments conducted under conditions of drought in 2007 prove that treated plants with SA derivatives in combination with NH_4^+ and K^+ ions coVP copolymers are able to maintain their degree of hydration at a higher level compared with control plants grown under accepted agricultural technology. The property of tioureidosalicylates to adjust consumption and productive use of water reserves in the soil, ultimately, ensures the formation of more vigorous plants and reduces crop losses under suboptimal moisture conditions.

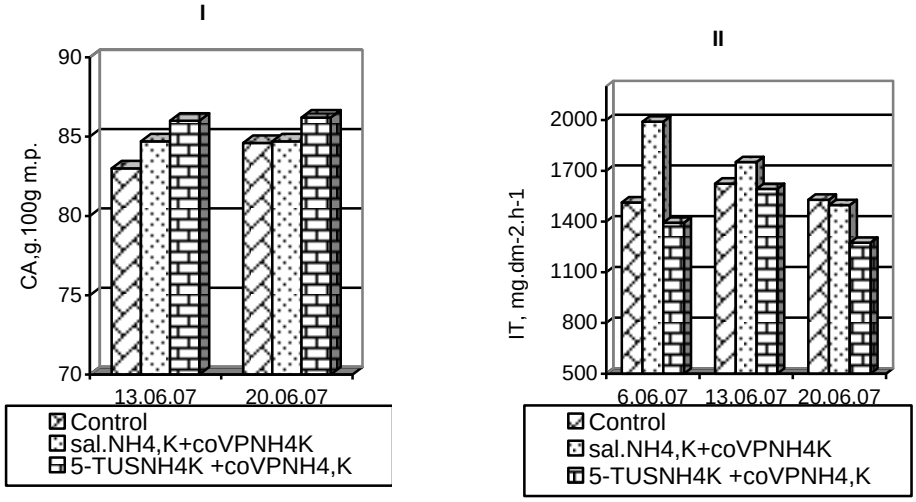

Fig. 1 - The influence of various BAS in combination with water-soluble polymers and DETHANE M45 fungicide on leaf water content and transpiration intensity (mg · dm^{-2} · h^{-1}) of *Cucumis sativus* L., Icar cv. plants.

Physiologically active compounds were established to be compatible with substances used to protect chemically the plants - Confidor, DITHANE M45 (fig. 1; table 4).

Table 4

The influence of NH_4^+, K^+ tioureidosalicylates in combination with bioactive polymers and water-soluble Confidor insecticide on productivity and yield *of Solanum tuberosum* L., s.Finca plants. Field exp. Bacioi, 2007

Variant	Productivity, g. plant		Yield, q. ha	
	2007	2008	2007	2008
Control + Confidor	105,7±2,6	234,8 ± 7,9	52,8± 0,45	117,4 ± 3,9
5-TUS-NH_4 K + Confidor	126,8± 3,1	265,1± 6,2	63,4 ± 0,34	132,6 ± 4,1
5-TUS-NH_4 K + coVPK + Confidor	127,9± 2,0	267,5 ± 4,3	63,9 ± 0,28	133,8 ± 1,1

The plant vigorousity, number of shoots and leaf area are bigger of the plants treated with 5-TUS+Confidor+coVPNH_4. The recording of plants' crop on the experimental areas shows that treatments of tubers before planting and foliar apparatus during the vegetative period with the combination of „5-TUS-NH_4K + Confidor" provided the addition of ≈ 13 to 20% compared with plants harvested from control plots. In the „5-TUS-NH_4K + Confidor" variant it was an increase of harvest with 14.0 -21.0%, compared to the control (Table 4). Crop structure analysis showed that there were tubers of low quality were formed in vegetative period in summer of 2007. The "little" and "very little" fractions predominate in

total mass. However, it is required to mention that from the average fraction of tubers in variants in which plants were treated with salicylic acid derivatives it is higher, compared with control.

Therefore, obtained experimental data allow concluding that tioureidosalicylates NH_4^+, K^+ have properties of PAS and condition the stimulation of the productive shoots growth and tubers formation, when being administered to the plants by the treatment of tubers before planting and foliar apparatus during the vegetative period. The concomitant use of tioureidosalicylates with Confidor insecticide does not neutralize the effect of preparations.

CONCLUSIONS

1. Ammonium and potassium tioureidosalicylates, and vinilpirolidin / methacrylate co-polymers have properties of physiologically active substances. Being used for treatment of seeds at sowing and foliar apparatus during the vegetation period, they condition the optimization of functional status, plant growth and development in both favorable conditions of humidity and moderate water deficit.

2. Their application in combination with water-soluble polymers has a beneficial effect on the potential achieving of productivity and plant yield.

3. Compounds are compatible with chemical protective substances against pests and pathogens; this provides economic advantages and ecological safety of the plant cultivation technology and enables to reduce labor costs.

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