EFFECT OF *IN VIVO* TREATMENTS WITH GA_3 FOR PRODUCTION *DE NOVO* SPROUTS IN SEED AND MERCANTILE POTATO

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Abstract: This paper presents results on the effect of different growth regulators on microtuberization induction in several varieties of seed and commercial potato (*Solanum tuberosum* L.) *in vivo*. The seed potatoes of the varieties Dido, Marabel, Agria and Agriko and commercial potatoes of the varieties Agria SR, Agria BE and Andrea were used in the experiment.

Key words: *in vivo,* potato, genotype, treatment

Introduction

Potato is the fourth important crop in the world after wheat, rice and maize. Potatoes are thought to have originated from high - mountain ranges of the Andes in South America. This crop is grown in 180 countries worldwide. According to the FAO statistic (https://faostat.fao.org), the largest producer of potatoes is Asia, then Europe, South America and North and Central America.

The very early beginning of potato cultivation in Macedonia is dating back 150-170 years ago. Today in the country, potatoes are grown on more than 13,000 hectares with an average yield of 20-40 t/ha, and every year the area of potato cultivation is extended (Statistical Yearbook of Republic of Macedonia, 2014).

Productivity of the tuber for obtaining sprouts depends of many factors like: lentgh of the day, temperature, physiological maturity of potato, water supply, growth regulators on plants (Gregory, 1965.).

Growth regulators have important and usefull effects on productivity of the tuber and that is linked with the hormonal balance (Stuart i Cathey, 1961.; Vreugdenhil i Struik, 2006.).

According to Rehman i rad., (2001) and Burton (1989) the treatment on the tubers with gibberellic acid GA_3, shows that the tubers have fast sprouting and must importantly is that they provide most number of sprouts.

The treatment on the tubers with GA_3 gets excellent results compared to those tubers which aren't treated with this growth regulator, because germination was slower and later, this was confirmed by researching of Timm i sar., (1962.).

According to researchment of Hu i sar.,(1998) which are examined the role of gibberellic acid, abscisic acid and sucrose into regulation of formation of tubers *in vitro*on potato, they are getting to conclusion that GA_3 shows like one of the better phytohormones during the tuberisation of potato.

The role of $GA_3$for production of sprouts is very important. In the studied that are performed on potato, GA_3 mainly is applied externally. These studies shows that with

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the application of $GA_3$are increasing growth and elongation of sprouts, and inhibiting obtaning of microtubers in medium (Smith i Rappaport, 1969; Kumar i Wareing, 1972).

Treating on tubers with GA_3 sprouts are growing faster and they produced much more sprouts opposed of untreated tubers (Rehman i rad., 2001; Burton, 1989).

Material and methods

The experiment was conducted in the Laboratory of Plant Biotechnology, Faculty of Agriculture, Goce Delcev University – Stip, Macedonia. The following potato varieties were used as starting material for the experiment:

- seed potatoes: Dido, Marabel, Agria, Ambition and Agriko;
- commercial potatoes: Agria SR, Agria BE and Andrea.

The variety Agria SR is cultivated in Strumica region, while the variety Agria BE is cultivated in Berovo region. The two regions differ in altitude, soil types and climate, thus the commercial potatoes of the same variety were treated as different starting material.

In vivo treatment of potato tubers with GA_3

Tubers of different potato seed and commercial varieties used in the experiment were treated with different concentrations of GA_3: 2, 12 and 22 ppm. To determine whether GA_3 had effect on sprouts emergence, a control K was used, where the tubers were not treated with GA_3 (Figure 1).

The GA_3 treatment was used for induction of rapid emergence and germination of sprouts. After GA_3 treatment, one week old sprouts were detached from the potato tubers and they were used as starting explants for further in vitro cultivation on MS medium enriched with different concentrations of phytohormones.

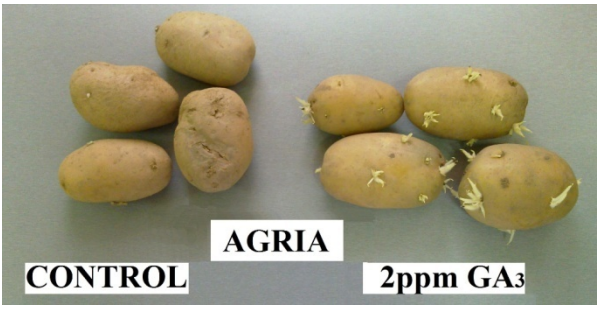


Figure 1. The effect of treatment with 2 ppm GA_3 for rapid sprouting and *de novo* production of sprouts in variety Agria compared to the control

Data analysis

All data were subjected to statistical analysis with IBM SPSS Statistical 21, one-way ANOVA and Duncan *posthoc* test, with the level of significance 0.05%.

Results and discussion

The resulats with this treatment with GA_3 in seed and mercantile potato are shown in Table 1.

Table 1. Effect of *in vivo* tretmants with GA_3 for production *de novo* sprouts in seed and mercantile potato

Production of sprouts						
GA_3 treatment	Genotype	Number of sprouts per tuber	Number of sprouts per eyelet	Lentgh of sprouts (mm)	Widht of sprouts (mm)	% of sprouts formation
Control	*Agria*	18	1,00c	2,61a	1,11bc	58,33f
	Agriko	19	1,00c	3,73a	1,00c	53,33e
	Andrea	6	1,00c	2,66a	1,00c	50,00d
	Ambition	13	1,00c	3,23a	1,23bc	31,25b
	Dido	12	2,33a	3,87a	1,50abc	50,00d
	Marabel	18	1,83ab	3,72a	1,42abc	64,00g
	agria BE	3	1,33bc	3,33a	1,66ab	25,00a
	agria SR	2	1,00c	3,00a	2,00a	33,33c
2 ppm	*Agria*	34	1,34b	2,29de	1,29b	76,93h
	Agriko	22	1,00c	5,95a	1,86ab	73,33d
	Andrea	10	1,20c	2,70cde	1,60ab	75,00e
	Ambition	19	1,10c	3,53bcd	1,57ab	35,29a
	Dido	16	2,93a	1,81e	1,66ab	76,90g
	Marabel	28	1,96b	3,85bc	1,92ab	76,00f
	agria BE	8	1,12c	4,75ab	1,62ab	50,00b
	agria SR	5	1,20c	6,00a	2,20a	66,66c
12 ppm	*Agria*	31	1,62ab	4,80b	2,03bcd	81,81d
	Agriko	33	1,29b	4,39bc	1,75cd	73,33b
	Andrea	12	1,57ab	2,75c	1,75cd	75,00c
	Ambition	22	1,86ab	5,77ab	1,86ab	50,00a
	Dido	25	1,66ab	2,72c	1,52d	91,66f
	Marabel	33	1,92ab	5,03ab	2,45b	88,46e
	agria BE	12	1,60ab	4,33bc	2,16bc	75,00c
	agria SR	7	2,20a	6,71a	3,00a	100,00g
22 ppm	*Agria*	43	1,00c	4,95bc	1,88c	100,00c
	Agriko	38	1,05c	4,57bc	1,86c	87,50b
	Andrea	19	1,21c	3,10c	1,89c	100,00c
	Ambition	23	1,17c	6,52b	2,69ab	62,50a
	Dido	29	1,96a	2,81c	1,60c	100,00c
	Marabel	40	1,65b	9,57a	2,47b	100,00c
	agria BE	17	1,05c	4,58bc	3,17a	100,00c
	agria SR	10	1,20c	6,90b	3,10a	100,00c

For stimulation of formation of sprouts, tubers were treated with GA_3 with diffrenet concentration like: 2 ppm, 12 ppm and 22 ppm. Also was one group of tubers that weren't treated with GA_3 and it was named like control group, which was treated with distilled water.

In control group, the production of sprouts, the best genotype is shown mercantile genotype *marabel* with 64% of formated sprouts, unless the treated genotype with 2 ppm GA_3 the higher value shown seed genotype *agria* with 76,93% formated sprouts.

In treatment with 12 ppm GA_3 the best value shown mercantile genotype *agria SR* with 100% formated sprouts.

The treatment of genotypes with 22 ppm GA_3 has given the greatest results at the most seed genotypes like: *agria, dido, marabel*; mercantile genotypes like: *andrea, agria BE, agria SR* with 100% formated sprouts.

Genotype *marabel* features with the highest precentage (64%) of formed sprouts within treatment with GA_3.

Genotype *dido* has given 2,33 sprouts per eyelet which represent the best value for this parametar and significantly is varies from the numbers of sprout per eyelet in all other genotypes.

The lentgh of formed sprouts is the largest on genotype *dido* (3,87 mm), but within significantly diffrence compared to the length of spouts obtainig from the others genotypes. Width of sprouts from 2 mm is the biggest on genotype *agria SR* and the same significantly differs from the width of sprouts of genotypes *agria* (1,11 mm), *agriko* (1 mm), *andrea* (1 mm) and *ambition* (1,23 mm).

The lentgh of sprouts is the biggest on genotype *agria SR* (6 mm) and significantly differs from the lenthg of sprouts on genotype *dido* (1,81 mm) with the treatment with 2 ppm GA_3.

The width of sprouts from 2,20 mm is the biggest of genotype *agria SR* and significantly is differs from the width of sprouts on genotype *agria* (1,29 mm), which the production of sprouts is stimulated with 2 ppm GA_3.

With the same treatment the genotype *dido* has shown 2,93 sprouts per eyelet which represent the best value for this parametar and significantly is differs from the numbers of sprouts per eyelet from all others genotypes..

The fact that gibberellins stimulated the production of sprouts on potato it is researched and verified form Clegg i Rappaport (1970); Claassenes i Vreugdenhill (2000.).

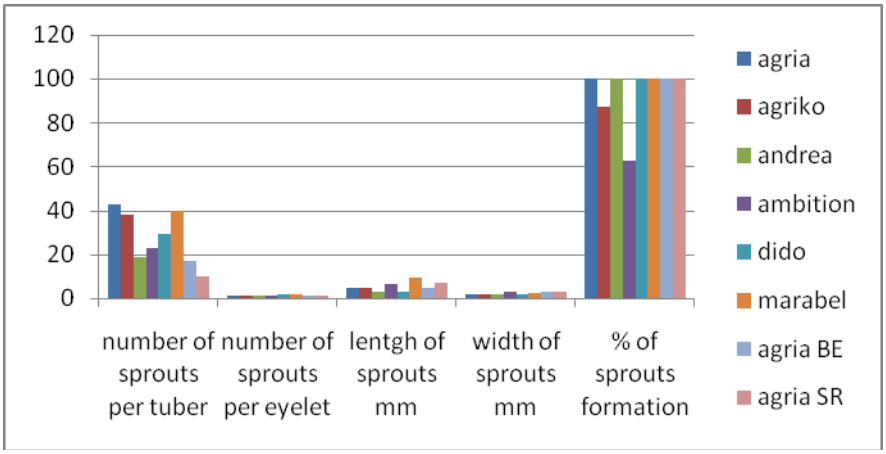
With the treatment of sprouts with 12 ppm GA_3 it is noticed that the numebr of sprouts per eyelet significantly shows the best value genotype *agria SR* with 2,20 sprouts per eyelet, which value significantly differs from the obtainig values from the all others genotypes.

The width of sprouts is the best on genotype *agria SR* (3 mm), which significantly differs from the width of sprouts from the genotype *dido* (1,52 mm).

With the lowest values of lentgh of sprouts are featured genotypes *dido* (2,72 mm) and *andrea* (2,75 mm), which significantly differs from the value that is obtain on genotype *agria SR* (6,71 mm).

On mercantile potato 100% of sprouts formation are getting on genotypes *andrea* and *agria SR*.

The gibberellins have capacity to end latency of tubers of potato (Herrera i rad., 1991.). The application of GA_3 with the higher concentartion increases and lenthens the sprouts (Lorreta i ras., 1995; Marinus i Bodleander, 1987; Rappaport i rad., 1957.).



Graph 1. Production of sprouts from tubers treated with 22 ppm GA_3

With treatment with 22 ppm GA_3 the largest sprouts has genotype *marabel* with 9,57 mm, which significantly is differs from the obtainig values of the others genotypes *dido* (2,81 mm) and *andrea* (3,10 mm).

The genotypes with treatment 22 ppm GA_3 with the best values are representet *agria BE* (3,17 mm) and *agria SR* (3,10 mm) which significantly are differs from the values of all others genotypes.

With the same treatment genotype *dido* has given 1,96 sprouts per eyelet which significantly is differs from the numebr of obtain sprouts per eyelet of all genotypes.

The treatment with 22 ppm GA_3 are shown as the most effective for both types examined potato. The applying of the highest doses of GA_3 results with 100% of sprouts formation on seed potato on the genotypes *dido, marabel* and *agria.* On mercantile potato 100% of sprouts formation are getting on genotypes *andrea, agria BE* and *agria SR.*

Conclusion

The results of our research indicates that mercantile potato it is more sensitive on the treatment with gibberellic acid and gets bigger percentage of formation of *de novo* sprouts for all tested genotypes and for all applicated concentration. From all applicated concentration with gibberellic acid the clearest results are obtaining with 22 ppm GA_3.

References

Bodlaender, K.B.A., Marinus, A. (1987). Effect of physiological age on growth vigor on seed potatoes. IBLV, Wageningen, Rapport 555, 142 pp.

Burton, W.G. (1989). The potato. Third edition, John Wiley and Sons, Inc New York, NY. P. 742.

Claassens, M.M.J., Vreugdenhil, D. (2000). Is dormancy breaking of potato tubers the reverse of tuber initiation? Potato Research (43), 347–369.

Clegg, M.D., Rappaport, L. (1970). Regulation of bud rest in tubers of potato, Solanum tuberosum L: VI. Biochemical changes induced in excised potato buds by gibberellic acid. Plant Physiol (45):8–13.

FAO – statistical yearbook foryear 2013.

Gregory, L.E. (1965) Physiology of tuberization in potato plants. Plant Physiol. (15):1328-1354.

Herrera, P., Huarte, J., Sanvito, F., Meda, P., Orci, L. and Vassalli, J. (1991). Embryogenesis of the murine pancreas; early expression of pancreatic polypeptide gene. Development (113), 1257-1265.

Kumar, D. and Wareing, P.F.(1972). Factors controlling stolon development in the potato plant. New Phytol. (71):639–648.

Lorreta, J., Miktzel, G., Nora, F. (1995). Dry Gibberellic acid combined With Talc and fir bark enhances early and tuber growth of shepody. Am. .Potato J. (72):545-550.

Rappaport, L., Lippert, L.F., Timm, H. (1957). Sprouting and plant growth of potato and tuber production as affected by chemical treatment of white potato seed pieces. Am. Potato J. (34):254-260.

Rehman, F., Lee, S.K., Kim, H.S., Jeon, J.H., Park, J., Joung, H. (2001). Dormancy breaking and effects on tuber yield of potato subjected to various chemicals and growth regulators under greenhouse conditions. Online J. Biol. Sci. 1(9):818-820.

Smith, O.E. and Rappaport, L. (1969). Gibberellins, inhibitors and tuber formation in potato. *Solanum tuberosum.* Amer.Potato, J., (46): 185-191.

Stuart, N.W., Cathey, H.M. (1961). Applied aspect of Gibberellins in potato. Plant Physiol. (12):369-378.

Timm, H., Rappaport, L., Bishop, J.C., Hoyle, B.J. (1962). Sprouting, plant growth, and tuber production as affected by chemical treatment of white potato seed pieces. Am. J. Potato Res. 39(3):107-115.

Vreugdenhil, D., Struik, P.C. (2006). An integrated view of the hormonal regulation of tuber formation in potato (Solanum tuberosum L.). Physiologia Plantarum 75(4):525-531.

Xu, X et al. (1998) The role of Gibberellin, Abscisic Acid and sucrose in the regulation of potato tuber formation *in vitro*. Plant physiology, June 1998 vol.117, (2): 575-584.