THE NUMBER OF VASCULAR BUNDLES OF SUGAR BEET (*BETA VULGARIS* L.) VARIETIES AND THE EFFECT OF GROWTH REGULATORS

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In exact field trials conducted in the years 1993 to 1995 the effect of biologically active substances (Rastim 30 DKV, Atonik and cytokinin-meta-hydroxybenzyl adenosine) applied in the growth stage 26–38 (June, spring application close before stand density took place when the beet plant had 14 leaves, and secondly some six weeks prior harvest (end of August, autumn or preharvest), in the growth stage 46, as exerted on the number and quality of harvested beet was studied. The treatment with Atonik had the best effects. It stepped up the root yield on an average of three years under study by 3.4% (in particular years by 2.5; 1.3 and 7.9%). An increase of white sugar was higher by 4.3% compared with the control. The treatment with Atonik and Rastim 30 DKV had a positive effect on the quality of beet roots, in particular by the drop of sodium and potassium content. Sugar beet content was only slightly affected by the substances investigated. The numbers of vascular bundles show the differences between varieties; the greatest number was found in the varieties Ibis and Petra in the Edda variety. Of the studied substances, Atonik affected the number of vascular bundles the most remarkably (+2% against untreated control).

sugar beet; growth regulators; yield formation; vascular bundles; sugar content; sugar beet quality

INTRODUCTION

Sugar beet root is a main supplying organ and crossroads of conductive passages connecting the root and above-ground systems. Conductive passages create main prerequisites for its high production capacity (Š e b á n e k , 1983). It has been proved in sugar beet that formed right leaves stimulate the production of circles of vascular bundles in root. In young plants to the development of the fifth pair of leaves the number of produced vascular bundles, including rosette, is almost identical with the number of pairs of right leaves. In later period the vascular bundles of single leaf are connected with several circles of vascular bundles. Thus, rosette and each circle of vascular bundles are connected with greater number of leaves. Three to five leaves fall to a circle of vascular bundles, formed later. Particular circles of vascular bundles are formed during root thickening. The growth of individual circles go on also after rise of new circle, so greater number of circles of vascular bundles grows simultaneously. There is an information that all circles of vascular bundles and rosettes in mature roots have an ability of cell growth and tissue thickening. It follows from it that the whole sugar root can cumulate reserve substances till the end of thickening.

Sugar beet plants can produce 12 to 14 circles of vascular bundles per root during a growing season (S t e h l í k , 1982). Fodder beet forms only a half number. It is evident from this that more ample vascular system has a positive effect as on sugar production in leaves as on its accumulation in roots. Therefore our attention has been focused on potential changes in production of particular circles of vascular bundles after plant treatment by biologically active substances – growth regulators.

The current plant production exploits plant growth regulators to control physiological processes in required direction of production. A main attention in sugar beet has been devoted to improvement of biological value of the seed, growth regulation and development during growing season aimed at yield increase of roots and sugar content. In recent years the effect of biologically active substances on sugar beet physiology, its yields and quality has been attracted by more authors (L a s s a , P e r e z - P e ň a , 1976; L e t o n , M i l f o r d , 1977; W e d d e r et al., 1985; G h a n e n , 1985; H a y a s a k a , 1988).

This study has been concentrated on the question whether different genotypes (varieties) have or have not different reaction to investigated biologically active substances and whether these changes reflect in different production of circles of vascular bundles in beet roots.

MATERIAL AND METHODS

Exact small-field trials have been established at the experimental station in Prague-Uhříněves. The experimental site is at an altitude of 295 above sea level, the plot belongs to the beet production region, wheat subtype. Fertile type with higher nutrient content, well available to plants, was produced on loess substrate. Considering the complex survey of soils and the great soil group an experimental site belongs to the luvisol. Average depth of topsoil is 32 cm and humus horizon has the depth of 70 cm. The humus content is medium (1.74 to 2.2%). Soil reaction is neutral, sorptive complex is saturated in the whole soil profile. P_2O_5 content in soil is good to ample which strongly

falls in subsoil. When agrochemical tests of soils were carried out in 1992 its content was 121 ppm. K_2O content, which has a continuous passage into lower layers in the soil, is good. In agrochemical tests of soils in 1992 its content was 200 ppm. Soils had favourable moisture pattern what was conditioned by developed illuvial horizons with good water retention.

Average daily air temperature was 8.3 °C, average daily air temperature during the growing season was 14.6 °C. The warmest month of the year is July with average daily air temperature of 18.2 °C. Winters are long with heavier frosts, which occur rarely as late spring frosts as late as at the end of April and prematurely as early as in October.

Average annual precipitation is 575 mm, of it 380 mm from April to September. The amplest precipitation is in June and July, while it is poorest in February.

According to Lang rain factor and annual sum of precipitation, an experimental site belongs to semihumid region. Drier climate pattern is tempered by prevailing western and north-western winds which reduce evaporation.

Growth regulators Rastim 30 DKV (0.3 $l.ha^{-1}$, active substance benzolinone), Atonik (0.6 $l.ha^{-1}$, aromatic nitrocompounds are active substances), highly effective Cytokinin „R“ (in concentration of 3.10^{-6} mol in 300 l water per ha, active substance N6-(meta-hydroxybenzyl)-adenosine). Plants were treated with growth regulators during the growing season by manual sprayer. The first spraying was applied at the growth stage 26–38 (June, spring application close prior to stand density) when beet plants had 6 to 14 leaves. The second spraying was done before harvest (end of August, autumn or preharvest) it the growth stage 46 (P u l k r á b e k , 1989). Sugar varieties Ibis (Strube), Edda (KWS) and normal varieties (transient varieties between yield-forming and sugar ones) Petra and Hilma from the Hilleshög company (Sweden–Czech Republic) were included in the trials. In some years the fodder beet variety Dorka was also studied. Different treatments were four times replicated, harvest area of single plot was 15 m^2. Plants were picked manually and weight of roots and beet tops was ascertained. Technological quality of beet roots was assessed from the sample of 20 roots at the Sugar Research Institute Praha, a.s. The number of circles of vascular bundles was assessed in ten roots in each sampling during the growing season and during harvest in 20 roots from each replication.

In the growing season of 1993 very dry and warm April was followed by very warm May, normal as for precipitation. June, July and September were characterized as humid months, whereas September was cold. August was normal in view of precipitation and temperature. The growing season of 1994 was characterized by subnormal June with ample precipitation and above-normal temperatures. In July precipitation was also subnormal and above-normal temperatures. August was above-normal as for precipitation and temperatures what resulted in strong retrovegetation of beet plants in the second half of the growing season. The year 1995 was unfavourable for sugar beet at the beginning of the growing season (delayed sowing, rainstorms at sprouting up and the drought by the end of June and beginning of July). The second half of the growing season allowed the sugar beet plants to create bulky leaf system and subsequently satisfied root yield and corresponding sugar content.

RESULTS AND DISCUSSION

In the years 1993 to 1995 the investigated substances had a variable effect on indicators of number (root yield, beet tops, white sugar) and technological quality (sugar content, content of sodium, potassium, alpha-amino-nitrogen and white sugar yield) in tested sugar beet varieties what has been also confirmed by the data presented by Kutina (1988) (Tabs. I–III). On an average for the investigated years and varieties the root yield was most affected and this was followed by the yield of polarization and white sugar. The treatment with Atonik, which increased the root yield on average for three investigated years by 3.4% (in particular years by 2.5; 1.3 and 7.9%), was the best. The yield of white sugar rose by 4.3% compared with an untreated control (in particular years by 2.1; 3.3 and 12.0%). Significant differences were recorded also between different varieties. On an average for the investigated years the greatest increase of root yield was present after double treatment with Atonik in the Hilma variety (9.6%). Similar results had the white sugar yield (12.2%).

Double treatment with Atonik and Rastim 30 DKV had a positive effect on the quality of roots, namely by the drop of sodium and potassium contents. Sugar content was a little affected by all studied substances, statistically insignificantly on average for investigated years and particular experimental years. On average for investigations sugar content of treated treatments in 1993 was slightly below the level of control, in 1994 slightly above control treatments and in 1995 there were positive trends of studied substances (1.1 to relative 5.5% increase). Summary indicator – theoretical white sugar yield – shows certain positive trends (statistically insignificant), i.e. increase in relative value on average for the investigated years, e.g. 1.3% increase after the treatment with Atonik. The Edda variety acted the least to studied substances by the change (required increase) in theoretical sugar yield, the best the Hilma variety (+1.8%) and Petra (+1.0%), the least Ibis (+0.4 %).

The survey of the effect of investigated substances on main harvest indicators: number (root and white sugar yields) and harvest quality (sugar content and theoretical white sugar yield) is presented in Tabs. I and II which

contain values found for different experimental years, three-year average and averages for investigated varieties and substances.

Our results assessing the effect of investigated substances on the number and quality of harvested sugar beet roots in four investigated varieties (Hilma, Edda, Petra and Ibis) generally coincide with the conclusion of the results made by the Research Institute of Chemical Technology Bratislava, Sugar Research Institute Praha-Modřany, and Central Control and Testing Institute for Agriculture Brno (Zahradníček, 1993; Henselová, 1993; Henselová et al., 1989; Rozkošová, 1993, 1994; Bajči, Micháliková, 1991; Giba et al., 1992).

Under the conditions of the Czech Republic a lot of substances were tested with various effect on the yield and quality of roots of harvested sugar beet. Recently Zahradníček (1991, 1993) tested the effects of bioregulator 6-benzylaminopurine (BAP) which had good effects on saccharose biosynthesis in such a way that sugar content of treated beet increased significantly during harvest (compared with the control – absolutely by 0.5 to 1.1%). Rimár (1992) confirmed a positive effect of Rastim 30 DKV (at a dose of 900–1 500 g per tonne of seed) and Stillit (at a dose of 200–300 g per tonne of seed) on the sugar beet yield.

Henselová et al. (1989, 1993) were involved in the problem of Rastim 30 DKV who present that average increase of profit in sugar beet treated with Rastim is 2 899 CZK (average for the years 1991 and 1992). Zahradníček et al. (1993) verified replicated foliar application as very positive and economically advantageous. The beet treated in such a way had (during separate industrial processing in beet sugar factory) significantly better technological parameters of basic material and its intermediates than untreated one. In the Domona variety in double application of Rastim 30 DKV Pulkrábek (1995) confirmed 5% increase in per hectare yield and insignificant influence on sugar content. The yield of digestion sugar rose relatively by 4.1% and white sugar yield by 3.6%. In the following trials Pulkrábek (1993) confirmed the effect of Elnoh on increase in sugar content of roots.

The structure of beet root can strongly affect the exploitation of biologically active substances in sugar beet. One of potential traits of the structure of beet root that can be simply observed, is also the number of circles of vascular bundles in the course of harvest and dynamics of its production during growing season (Šebánek et al., 1983; Stehlík, 1982). During the growing season, as a rule in three week-intervals, in the years 1993 and 1994 the number of circles of vascular bundles in roots of different varieties was followed and averages for investigated varieties and substances were calculated (Figs. 1 to 4). Tab. III presents average values calculated from individual investigations for a growing season. Correspondingly, the number

I. The effect of investigated biologically active substances on the root yield and sugar content

Variety	Investigated substance	1993	1994	1995	Average	1993	1994	1995	Average
		root yield (t/ha)				sugar content (%)			
Hilma	control	76.6	55.2	46.1	59.3	18.2	16.1	14.2	16.2
Hilma	Cytokinin 2x	69.0	56.5	51.4	59.0	18.0	16.8	14.4	16.4
Hilma	Atonik 2x	82.3	56.1	56.6	65.0	18.2	16.7	14.8	16.6
Hilma	Rastim 30 DKV 2x	74.3	58.6	57.8	63.6	18.4	16.3	14.6	16.4
Edda	control	74.1	58.2	46.9	59.7	19.3	17.1	14.4	16.9
Edda	Cytokinin 2x	75.2	59.7	49.4	61.4	18.8	17.0	15.0	16.9
Edda	Atonik 2x	74.2	58.6	46.9	59.9	19.1	17.1	14.6	16.9
Edda	Rastim 30 DKV 2x	75.6	61.2	47.1	61.3	19.1	17.0	14.2	16.7
Ibis	control	90.5	60.6	47.1	66.1	19.2	16.5	14.8	16.8
Ibis	Cytokinin 2x	91.7	62.3	51.3	68.4	19.3	16.5	14.9	16.9
Ibis	Atonik 2x	92.7	62.3	46.8	67.2	19.5	16.6	15.0	17.0
Ibis	Rastim 30 DKV 2x	88.8	62.4	47.4	66.2	19.2	16.4	14.3	16.6
Petra	control	89.4	60.2	42.1	63.9	19.6	16.1	13.1	16.3
Petra	Cytokinin 2x	86.0	60.1	44.7	63.6	19.6	16.3	13.4	16.4
Petra	Atonik 2x	89.3	60.3	46.0	65.2	19.3	16.2	13.4	16.3
Petra	Rastim 30 DKV 2x	83.7	61.4	46.8	64.0	19.5	16.2	13.9	16.5
Variety		root yield (t/ha)				sugar content (%)			
Hilma		75.6	56.7	53.0	61.7	18.2	16.5	14.5	16.4
Edda		74.8	59.4	47.6	60.6	19.1	17.1	14.5	16.9

Continuation of Tab. I

Ibis	90.9	61.9	48.1	67.0	19.3	16.5	14.8	16.9
Petra	87.1	60.5	44.9	64.2	19.5	16.2	13.5	16.4
Average – sugar beet	82.1	59.6	48.4	63.4	19.0	16.5	14.3	16.6
Investigated substance in sugar beet	root yield (t/ha)				sugar content (%)			
Control	82.7	58.6	45.6	62.3	19.1	16.5	14.1	16.6
Cytokinin 2x	80.5	59.7	49.2	63.1	18.9	16.6	14.4	16.7
Atonik 2x	84.6	59.3	49.1	64.3	19.0	16.6	14.5	16.7
Rastim 30 DKV 2x	80.6	61.0	49.6	63.8	19.0	16.4	14.2	16.6
Average – sugar beet	82.1	59.6	48.4	63.4	19.0	16.5	14.3	16.6

II. The effect of investigated biologically active substances on the white sugar yield and theoretical yielding of white sugar

Variety	Investigated substance	1993	1994	1995	Average	1993	1994	1995	Average
		white sugar yield (t/ha)				white sugar yielding (%)			
Hilma	control	12.1	7.5	5.2	8.3	15.8	13.5	11.4	13.6
Hilma	Cytokinin 2x	10.7	8.1	6.0	8.3	15.5	14.3	11.8	13.8
Hilma	Atonik 2x	12.9	8.0	6.9	9.3	15.7	14.3	12.2	14.1
Hilma	Rastim 30 DKV 2x	11.9	7.9	6.9	8.9	16.1	13.5	11.9	13.8
Edda	control	13.0	8.5	5.6	9.0	17.6	14.7	11.9	14.7
Edda	Cytokinin 2x	12.8	8.5	8.2	9.2	17.1	14.3	12.5	14.6
Edda	Atonik 2x	12.9	8.5	5.7	9.0	17.3	14.6	12.1	14.7

Continuation of Tab. II

Edda	Rastim 30 DKV 2x	13.1	8.8	5.5	9.1	17.3	14.4	11.6	14.5
Ibis	control	15.7	8.3	5.8	9.9	17.4	13.7	12.3	14.5
Ibis	Cytokinin 2x	16.0	8.7	6.4	10.4	17.5	13.9	12.5	14.6
Ibis	Atonik 2x	16.4	8.6	5.9	10.3	17.7	13.9	12.6	14.7
Ibis	Rastim 30 DKV 2x	15.4	8.6	5.6	9.9	17.4	13.7	11.8	14.3
Petra	control	15.7	8.1	4.5	9.4	17.6	13.5	10.6	13.9
Petra	Cytokinin 2x	15.2	8.2	4.8	9.4	17.6	13.7	10.8	14.0
Petra	Atonik 2x	15.4	8.3	5.0	9.6	17.3	13.7	10.9	14.0
Petra	Rastim 30 DKV 2x	14.5	8.4	5.4	9.4	17.4	13.7	11.5	14.2
Variety			white sugar yield (t/ha)				white sugar yielding (%)		
Hilma		11.9	7.9	6.3	8.7	15.8	13.9	11.8	13.8
Edda		13.0	8.6	5.7	9.1	17.3	14.5	12.0	14.6
Ibis		15.9	8.6	5.9	10.1	17.5	13.8	12.3	14.5
Petra		15.2	8.3	4.9	9.5	17.5	13.7	11.0	14.0
Average – sugar beet		14.0	8.3	5.7	9.3	17.0	14.0	11.8	14.3
Investigated substance in sugar beet			white sugar yield (t/ha)				white sugar yielding (%)		
Control		14.1	8.1	5.3	9.2	17.1	13.9	11.6	14.2
Cytokinin 2x		13.7	8.4	5.9	9.3	16.9	14.0	11.9	14.3
Atonik 2x		14.4	8.4	5.9	9.6	17.0	14.1	11.9	14.4
Rastim 30 DKV 2x		13.7	8.4	5.8	9.3	17.0	13.8	11.7	14.2
Average – sugar beet		14.0	8.3	5.7	9.3	17.0	14.0	11.8	14.3

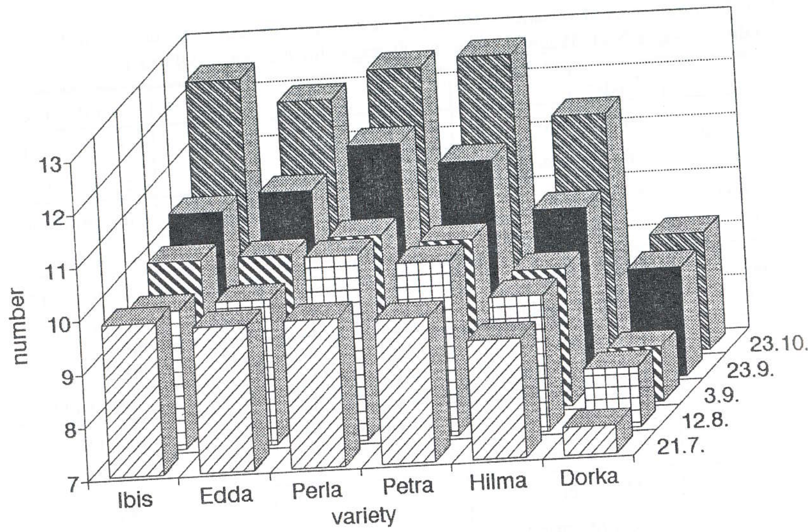
III. Two-factor analysis of variance - The effect of biologically active substances on the number and quality of sugar beet (Prague-Uhříněves, averages for the years 1993 to 1995)

Indicator	Factor	*F*	*P*-value	Significance
Root yield	BAL effect	0.597	0.6328	insignificant
	effect of varieties	9.665	0.0036	significant
Beet tops yield	BAL effect	0.220	0.8799	insignificant
	effect of varieties	1.208	0.3515	significant
Sugar content	BAL effect	1.286	0.3373	insignificant
	effect of varieties	15.48	0.0007	significant
Alfa amino – N	BAL effect	0.176	0.997	insignificant
	effect of varieties	5.541	0.0197	significant
Potassium content	BAL effect	1.653	0.2455	insignificant
	effect of varieties	137.3	7.8-E08	significant
Sodium content	BAL effect	0.474	0.7082	insignificant
	effect of varieties	3.947	0.047	significant
Productivity	BAL effect	1.005	0.4343	insignificant
	effect of varieties	30.67	4.6E-05	significant
Polarized sugar yield	BAL effect	1.413	0.3016	insignificant
	effect of varieties	18.08	0.0004	significant
White sugar yield	BAL effect	1.46	0.2894	insignificant
	effect of varieties	20.07	0.0002	significant
Theoretical yielding	BAL effect	1.461	0.2891	insignificant
	effect of varieties	27.54	7.2E-05	significant

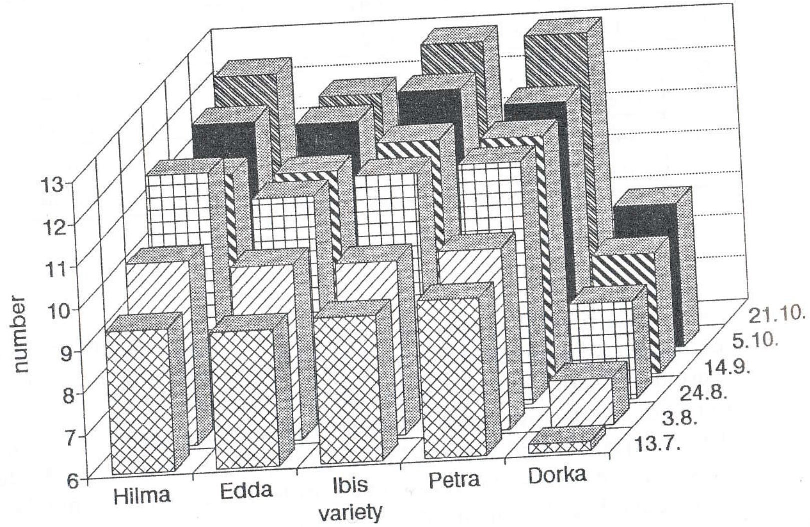
Note: F crit. = 3.862

of circles of vascular bundles in harvested roots years was assessed (Tab. IV). Tab. V presents per cent effect of the followed substances on the number of circles of vascular bundles during harvest and growing season.

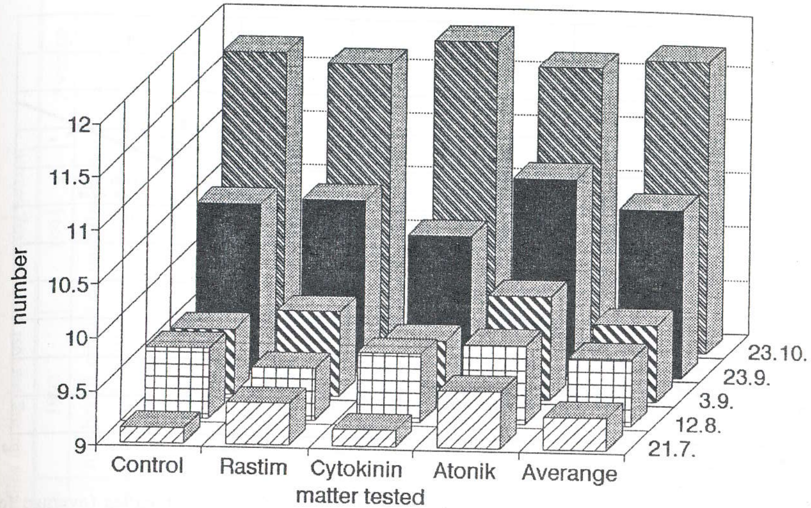
The counts indicate the difference between varieties, the greatest count was found in the varieties Ibis and Petra, while the smallest one was in the Edda variety. The substances investigated had a very little influence on the number of circles of vascular bundles, the most significant was attained by the Atonik preparation. Double treatment of sugar beet plants with Atonik increased the number of vascular bundles on average for the investigation, in particular during the growing season (2% increase compared with untreated control).



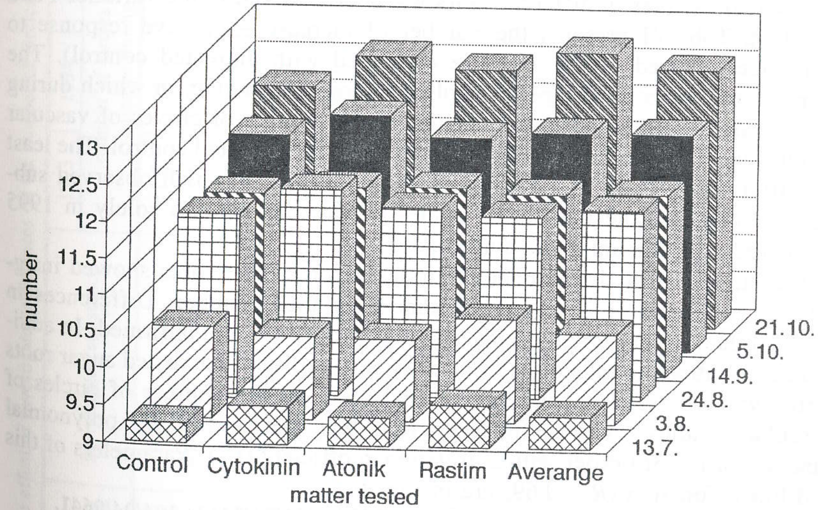
1. Dynamics of formation of circles of vascular bundles in investigated varieties in 1993



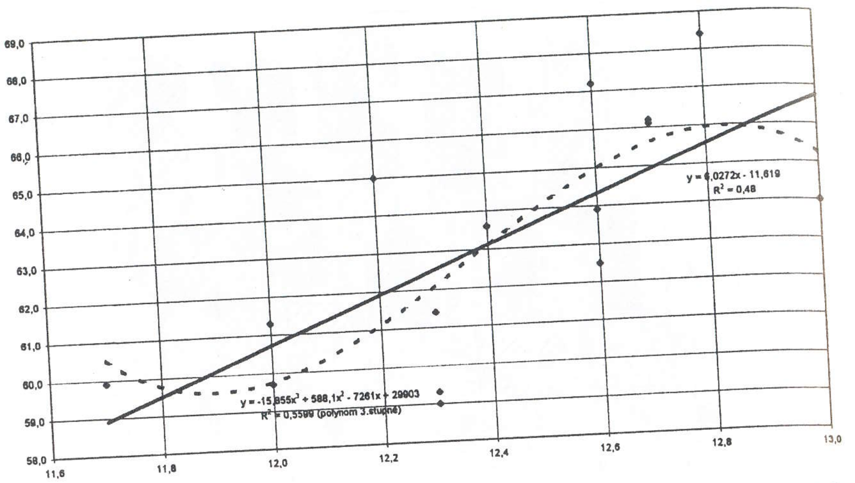
2. Dynamics of formation of circles of vascular bundles in investigated varieties in 1994



3. The effect of investigated substances on dynamics of formation of circles of vascular bundles in 1993



4. The effect of investigated substances on dynamics of formation of circles of vascular bundles in 1994



5. The dependence of root yields on the number of circles of vascular bundles (average for 1993–1995); x-axis – number of circles of vascular bundles, y-axis – root yields t/ha

The effect of investigated substances on the dynamics of formation of circles of vascular bundles in different years was more marked in the varieties Petra and Ibis. Tab. VI presents the number of increase – positive response to substances applied (102% increase compared with untreated control). The Petra variety responded most to applied biologically active, in which during three years and three observed substances the number of circles of vascular bundles increased in five cases compared with the untreated control. The least sensitivity was found in the yielding variety Hilma in which observed substances increased the number of circles of vascular bundles solely in 1995 compared with the untreated control.

Investigations of the number of circles in sugar beet roots showed insignificant influence of observed substances on their number. Differences in their production in individual investigated varieties were confirmed. In addition, correlations to indicators of number and quality of harvested sugar roots were evaluated. The dependence of root yield on the number of circles of vascular bundles (average for 1993 to 1995) is expressed by polynomial function of the 3rd order with correlation coefficient 0.75. Parameters of this and linear function ($R = 0.69$) are in Fig. 5.

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IV. The effect of investigated substances on the number of circles of vascular bundles during harvest and growing season

Variety	Investigated substance	1993	1994	1995	Average	1993	1994	Average
		number of circles of vascular bundles during harvest				number of circles of vascular bundles – average for investigations during growing season		
Hilma	control	11.6	12.9	12.4	12.3	10.3	11.1	10.7
Hilma	Cytokinin 2x	11.5	12.2	13.3	12.3	9.8	11.1	10.5
Hilma	Atonik 2x	11.2	11.8	13.5	12.2	10.3	11.1	10.7
Hilma	Rastim 30 DKV 2x	11.7	12.5	13.0	12.4	9.8	11.2	10.5
Edda	control	12.2	10.7	13.1	12.0	10.3	10.6	10.5
Edda	Cytokinin 2x	12.6	12.2	12.2	12.3	10.3	11.0	10.7
Edda	Atonik 2x	11.6	11.6	11.8	11.7	10.8	10.6	10.7
Edda	Rastim 30 DKV 2x	11.6	12.5	11.9	12.0	10.3	11.2	10.8
Ibis	control	12.4	12.3	13.3	12.7	10.4	11.1	10.8
Ibis	Cytokinin 2x	12.7	13.0	12.6	12.8	10.8	11.4	11.1
Ibis	Atonik 2x	12.5	13.2	12.2	12.6	10.5	11.4	11.0
Ibis	Rastim 30 DKV 2x	12.3	13.0	12.7	12.7	10.8	11.4	11.1
Petra	control	13.0	12.8	12.0	12.6	10.6	11.3	11.0
Petra	Cytokinin 2x	12.1	13.0	12.2	12.4	11.0	11.6	11.3
Petra	Atonik 2x	12.1	13.2	12.4	12.6	11.2	11.5	11.4
Petra	Rastim 30 DKV 2x	13.6	12.8	12.5	13.0	11.0	11.2	11.1

Variety	number of circles of vascular bundles during harvest				number of circles of vascular bundles – average for investigations during growing season		
Hilma	11.5	12.4	13.1	12.3	10.1	11.1	10.6
Edda	12.0	11.8	12.3	12.0	10.4	10.9	10.6

Continuation of Tab. IV

Ibis	12.5	12.9	12.7	12.7	10.6	11.3	11.0
Petra	12.7	13.0	12.3	12.6	11.0	11.4	11.2
Average – sugar beet	12.2	12.5	12.6	12.4	10.5	11.2	10.8
Investigated substance in sugar beet	number of circles of vascular bundles during harvest				number of circles of vascular bundles – average for investigations during growing season		
Control	12.3	12.2	12.7	12.4	10.4	11.0	10.7
Cytokinin 2x	12.2	12.6	12.6	12.5	10.5	11.3	10.9
Atonik 2x	11.9	12.5	12.5	12.3	10.7	11.2	10.9
Rastim 30 DKV 2x	12.3	12.7	12.5	12.5	10.5	11.3	10.9
Average – sugar beet	12.2	12.5	12.6	12.4	10.5	11.2	10.8

V. The effect of investigated substances on the number of circles of vascular bundles during harvest and growing season expressed in per cent of untreated control

Variety	Investigated substance	1993	1994	1995	Average	1993	1994	Average
		number of circles of vascular bundles during harvest				number of circles of vascular bundles – average for investigations during growing season		
Hilma	control	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hilma	Cytokinin 2x	99.1	94.6	107.3	100.3	95.1	100.0	97.7
Hilma	Atonik 2x	96.6	91.5	108.9	98.9	100.0	100.0	100.0
Hilma	Rastim 30 DKV 2x	100.9	96.9	104.8	100.8	95.1	100.9	98.1
Edda	control	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Edda	Cytokinin 2x	103.3	114.0	93.1	102.8	100.0	103.8	101.9
Edda	Atonik 2x	95.1	108.4	90.1	97.2	104.9	100.0	102.4

Continuation of Tab. V

Edda	Rastim 30 DKV 2x	95.1	116.8	90.8	100.0	100.0	105.7	102.9
Ibis	control	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ibis	Cytokinin 2x	102.4	105.7	94.7	100.8	103.8	102.7	103.3
Ibis	Atonik 2x	100.8	107.3	91.7	99.7	101.0	102.7	101.9
Ibis	Rastim 30 DKV 2x	99.2	105.7	95.5	100.0	103.8	102.7	103.3
Petra	control	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Petra	Cytokinin 2x	93.1	101.6	101.7	98.7	103.8	102.7	103.2
Petra	Atonik 2x	93.1	103.1	103.3	99.7	105.7	101.8	103.7
Petra	Rastim 30 DKV 2x	104.6	100.0	104.2	102.9	103.8	99.1	101.4
Variety		number of circles of vascular bundles during harvest				number of circles of vascular bundles – average for investigations during growing season		
Hilma		94.5	98.9	103.8	99.1	95.6	99.6	97.6
Edda		98.6	94.1	97.5	96.7	99.2	97.1	98.1
Ibis		102.5	103.2	101.0	102.2	101.1	101.3	101.2
Petra		104.4	103.8	97.7	101.9	104.2	102.0	103.1
Average – sugar beet		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Investigated substance in sugar beet		number of circles of vascular bundles during harvest				number of circles of vascular bundles – average for investigations during growing season		
Control		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Cytokinin 2x		99.5	104.0	99.2	100.6	100.7	102.3	101.5
Atonik 2x		96.4	102.6	98.5	98.9	102.9	101.1	102.0
Rastim 30 DKV 2x		99.9	104.9	98.8	100.9	100.7	102.1	101.4
Average – sugar beet		98.9	102.8	99.1	100.1	101.1	101.4	101.2

VI. Response of sugar beet varieties to treatment with biologically active substances (effect of the number of circles of vascular bundles, increase of indicator over 102.0% compared with untreated control)

Variety	1993 year	1994 year	1994 year	Average	Number of increases	Investigated indicator
Hilma	0	0	3	0	3	12.3
Edda	1	3	0	1	4	12.0
Ibis	1	3	0	3	4	12.7
Petra	1	2	2	1	5	12.6

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Počet svazků cévních u odrůd řepy cukrové (*Beta vulgaris* L.) a jejich ovlivnění regulátory růstu.

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Stavba řepné bulvy může silně ovlivňovat využití biologicky aktivních látek u cukrovky. Jedním z možných, jednoduše sledovatelných znaků stavby řepné bulvy, může být i počet kruhů cévních svazků v době sklizně a dynamika jejich tvorby v průběhu vegetace (Š e b á n e k et al., 1983).

V přesných polních pokusech na pokusné stanici KRV v Praze-Uhříněvsi v povětrnostně rozdílných letech 1993, 1994 a 1995 byl sledován vliv biologicky aktivních látek aplikovaných ve fázi 26–38 a 46 (Pulkrábek, 1989) na počet kruhů svazků cévních v bulvách vybraných odrůd cukrové řepy. V průběhu vegetace, zpravidla v třítýdenních intervalech, byl sledován počet kruhů cévních svazků v bulvách jednotlivých variant a byly vypočítány průměry pro sledované odrůdy (Hilma, Edda, Ibis a Petra) a látky (Rastim 30 DKV, Atonik a cytokinin-meta-hydroxybenzyl adenozin). V tab. IV jsou uvedeny hodnoty vypočítané z jednotlivých sledování za vegetaci. Obdobně byl hodnocen i počet kruhů cévních svazků u sklizených bulev (tab. IV). Na obr. 1 až 4 je uvedena dynamika tvorby kruhů cévních svazků v průběhu vegetace. V tab. V je vyjádřen v procentech vliv sledovaných látek na počet kruhů cévních svazků při sklizni a za vegetace.

Zjištěné počty ukazují na statisticky významné diference mezi odrůdami – nejvyšší počet byl zjištěn u odrůd Ibis (12,7) a Petra (12,6) a nejnižší u cukernaté odrůdy Edda (12,0). Sledované látky ovlivnily počet kruhů cévních svazků velmi málo, nejvýrazněji je ovlivnil Atonik. Dvojí ošetření cukrovky Atonikem statisticky významně zvýšilo počet kruhů cévních svazků především během vegetace (zvýšení o 2 % proti neošetřené kontrole). Vliv sledovaných látek na dynamiku tvorby kruhů cévních svazků v jednotlivých letech byl výraznější u odrůd Petra a Ibis (statisticky významné diference). Jako statisticky významný faktor se projevil i vliv ročníku. Vysoce průkazné diference ročníkových rozdílů byly prokázány mezi lety 1993 a 1994 a průkazné diference mezi lety 1994 a 1995. Rozdíly zjištěné mezi roky 1993 a 1995 nebyly průkazné. V tab. VI je uveden počet zvýšení počtů kruhů cévních svazků jako pozitivní reakce na aplikované látky (zvýšení proti neošetřené kontrole nad 102 %). Závislost výnosu bulev na počtu kruhů cévních svazků (průměr 1993–1995) vystihuje polynomická funkce 3. stupně s korelačním koeficientem 0,75. Parametry této funkce a funkce lineární (R = 0,69) jsou znázorněny na obr. 5.

Naše výsledky hodnotící vliv sledovaných látek na množství a jakost sklizených bulev cukrovky u čtyř odrůd (Hilma, Edda, Petra a Ibis) se v obecné poloze shodují se závěry pokusů uskutečněných VÚCHT v Bratislavě, VUC v Praze a ÚKZÚZ v Brně (Zahradníček, 1993; Henselová et al., 1993; Rozkošová, 1994). Sledované látky ovlivnily ukazatele množství a technologické jakosti u ověřovaných odrůd cukrovky velmi variabilně. V průměru sledovaných let a odrůd byl nejvýrazněji ovlivněn výnos bulev a následně i výnos polarizačního a bílého cukru. Nejpříznivěji se projevilo ošetření Atonikem (statisticky průkazně v roce 1995), který zvýšil výnos bulev v průměru tří sledovaných let o 3,4 % (v jednotlivých letech o 2,5 %, 1,3 % a 7,9 %). Vzestup výnosu bílého cukru byl ještě výraznější, a sice o 4,3 % proti neošetřené kontrole (v jednotlivých letech o 2,1 %, 3,3 % a 12,0 %). Výrazné diference byly i mezi jednotlivými odrůdami. V průměru sledovaných let bylo nejvyšší zvýšení výnosu bulev po dvojím ošetření Atonikem u odrůdy Hilma (9,6 %) a obdobně nejvyšší zvýšení výnosu bílého cukru (12,2 %). Statisticky významné rozdíly v průměru sledovaných let, dané aplikací biologicky aktivních látek, byly zjištěny u výnosu bulev u odrůdy Edda a výtěžnosti bílého cukru u odrůdy Petra.

Technologickou jakost pozitivně ovlivnilo dvojí ošetření Atonikem a Rastimem 30 DKV – projevilo se především poklesem obsahu sodíku a draslíku. Cukernatost byla sledovanými látkami ovlivněna velmi málo. V průměru sledování byla cukernatost ošetřených variant roce 1993 mírně pod úrovní kontroly, v roce 1994 mírně nad kontrolními variantami a v roce 1995 se prokázaly pozitivní tendence sledovaných látek (zvýšení o 1,1 až 2,5 rel. %). Souhrnný ukazatel, teoretická výtěžnost bílého cukru, ukazuje na určité pozitivní tendence, tj. zvýšení v relativní hodnotě v průměru sledovaných let, například po ošetření Atonikem vzestup o 1,3 %. Na sledované látky nejméně reagovala změnou (požadovaným zvýšením) teoretické výtěžnosti cukru odrůda Edda, nejpříznivěji odrůda Hilma (+1,8 %) a Petra (+1,0 %), méně výrazně i Ibis (+0,4 %). Přehled vlivu sledovaných látek na hlavní sklizňové ukazatele množství a jakosti sklizně je uveden v tab. I a II, statistické vyhodnocení je uvedeno v tab. III.

cukrovka; regulátory růstu; tvorba výnosu; cévní svazky; cukernatost; kvalita cukrovky

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