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PRODUCTION PARAMETERS OF SUGAR BEET YIELD DEPENDING ON THE VARIETY AND FOLIAR APPLICATION OF ATONIK AND POLYBOR 150 PREPARATIONS

PRODUKČNÉ PARAMETRE CUKROVEJ REPY V ZÁVISLOSTI OD ODRODY A FOLIÁRNEJ APLIKÁCII PRÍPRAVKOV ATONIK A POLYBOR 150

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The influence of the sugar beet variety as well as biologically active compounds Atonik and Polybor 150 treatments on sugar beet root yield, digestion and refined sugar yield was observed in a polyfactorial field trial carried out on a medium heavy brown soil between 2002 and 2004. There was a high significant influence of weather conditions as well as Atonik and Polybor 150 treatments on the formation of the observed yield parameters. From the point of root yield, sugar beet digestion and refined sugar yield, it was figured out that the most optimum variant under these trial soil-weather conditions was the variant C (Atonik: 0.4 $l.ha^{-1}$ – 2nd postemergent herbicidal application + Atonik + Polybor 150: 0.6 + 2.5 $l.ha^{-1}$ – 3rd postemergent herbicidal application + Atonik + Polybor 150: 0.6 + 2.5 $l.ha^{-1}$ – 1st fungicidal treatment). Higher values of root yield and refined sugar yield achieved variety Flair in comparison with Swing (+ 1.28 $t.ha^{-1}$ and 0.22 $t.ha^{-1}$), higher values of sugar beet digestion achieved Swing in comparison with Flair (+0.26 %).

Key words: sugar beet, foliar treatment, root yield, digestion, refined sugar yield.

The yield and technological quality of sugar beet root formation is a complex process influenced by factors that create a composition of growth, physiological and biochemical processes. Growth processes of sugar beet as well as other crops reflect developmental and biochemical processes so that the links of this chain are dependent on soil-weather conditions [2, 3].

As well as the basic technological factors which have to be respected in the system of the evaluation of the sugar beet production process, new factors are searched for to be introduced. The influence of these new factors should be evaluated positively on sugar beet yield quantity and quality. Excepting the possibilities of using high effective biological material, preparations based on biologically active compounds belong to the new factors. Present research and the cultivation system, pays them more attention permanently [6, 7, 9].

The utilisation of biologically active compounds is one of the possible ways of sugar

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yield stabilisation. The key stone of the growth regulator utilisation is not only the increase of the sugar yields but also the reduction of stress (extreme weather conditions, wrong pesticide applications), higher resistance against damaging agents as well as the better utilisation of some other cultivation measure [1].

Biologically active compounds are effective for the regulation of growth and developmental processes in plants. They influence the yield formation dynamics and positively increase the utilisation of the variety of genetic potential. There are two approaches to their application; foliar application on a leaf surface and soil application because they affect not only the physiological processes of the plant but the soil environment too [5, 8].

The aim of this research project was to evaluate the influence of the sugar beet variety as well as the biologically active compounds Atonik and Polybor 150 treatments on sugar beet root yield, digestion and refined sugar yield.

MATERIAL AND METHOD

This research was conducted as a polyfactorial field trial established in agroecological conditions in the warm corn-producing area at the Slovak University of Agriculture in Nitra – Centre of Plant Biology and Ecology at Dolná Malanta between 2002 and 2004. The weather conditions during the experiment are stated in table 1.

The trial was established as a randomised block design with three repetitions. The area of one trial unit was 32.4 m^2 (5.4 × 6 m). There were 24 trial units in total. Monogerm sugar beet varieties Swing and Flair were used. Biologically active compounds of Atonik and Polybor 150 preparations were tested as a foliar treatment (tab. 2).

Atonik is a plant growth stimulator. It is a foliar preparation, a mixture of three aromatic nitro-compounds based on sodium nitrophenolate (sodium 2 – nitrophenolate (ONP-Na 2 g/l),

Table 1

Weather conditions

Month	n 30 (1951 – 1980) (1)		2002		2003		2004	
	°C (2)	mm (3)	°C	mm	°C	mm	°C	mm
I.	−1.7	31	−1.2	11.9	−1.9	33.0	−3.3	55.9
II.	0.5	32	3.5	35.7	−1.8	0.7	1.6	31.1
III.	4.7	33	6.3	28.7	5.1	2.3	4.7	52.8
IV.	10.1	43	9.9	44.5	10.7	27.0	11.7	36.3
V.	14.8	55	17.4	62.3	18.8	44.5	14.3	36.9
VI.	18.3	70	19.6	68.5	21.3	6.5	17.9	93.8
VII.	19.7	64	22.1	50.9	21.2	92.0	20.0	33.8
VIII.	19.2	58	20.8	90.0	22.7	23.8	20.1	19.4
IX.	15.4	37	14.9	62.1	15.8	15.5	14.7	36.7
X.	10.1	41	9.7	78.2	7.9	66.0	11.7	45.3
XI.	4.9	54	8.0	42.0	7.0	32.,9	5.5	45.7
XII.	0.5	43	−0.4	37.7	0.9	24.0	0.8	26.8
$\bar{x}$I. – XII. (4)	9.7	–	10.9	–	10.6	–	9.9	–
$\bar{x}$IV. – IX. (5)	16.25	–	17.45	–	18.4	–	16.45	–
ΣI. – XII. (6)	–	561	–	612.5	–	368.2	–	514.5
ΣIV. – IX. (7)	–	327	–	378.3	–	209.3	–	256.9

(1) Long-term (30-years) normal, (2) average air temperature, (3) sum of precipitation, (4) average air temperature per year, (5) average air temperature per vegetation period, (6) sum of precipitation per year, (7) sum of precipitation per vegetation period

sodium 4 – nitrophenolate (PNP-Na 3 g/l) a sodium 2 methoxy – 5 – nitrophenolate (5NG-Na 1 g/l).

Polybor 150 is special high-concentrated fertiliser applied as an additional nutrition for agricultural crops with higher demands on boron. A special fertiliser form (amine – polyborate complex) insures the quick transfer to plant tissue as well as a wash resistance.

The preceding crop was winter wheat. The sugar beet stand was established fully in accordance with cultivation technology. A final row distance of 165 mm was used. The refined sugar yield was calculated according to the formula (refined sugar yield = root yield × refined sugar × 0.01). The resulting data was evaluated by the Multifactor Analysis of Variance (Tukey test) in the statistical program Statgraphics.

RESULTS AND DISCUSSION

Root yield

In the trial period of 2002–2004, there was an average root yield of 56.28 $t.ha^{-1}$, yield quantity variation within the years was 20.38 $t.ha^{-1}$. These yield differences were caused not only by weather conditions but also by genetically fixed characteristics of varieties (tab. 4). Presented results are in accordance with findings of B a j č i et al. [3] and with Č e r n ý, P a č u t a [4]; the selection of variety depends on its plasticity, i.e. the possibility of adapting to specific agro-ecological conditions.

There was a higher root yield at variety Flair in comparison with Swing + 1.28 $t.ha^{-1}$ (2.30 % rel.). During the trial period the yield differences were as follows: Swing +1.97 $t.ha^{-1}$ (2.47 % rel.) (2002), Flair + 4.10 $t.ha^{-1}$ (8.62 % rel.) (2003), Flair +1.52 $t.ha^{-1}$, (3.12 % rel.). The average yield of the trial period and average yields of the single years 2002 and 2004 were influenced by variety non-significantly (tab. 3). The influence of variety was statistically significant in 2003. Sugar beet root yield was influenced by Atonik and Polybor 150 preparations high significantly during the whole trial period. The highest increase of yield was found at the variant C. The increase of root yield was + 5.31 $t.ha^{-1}$, (9.91 % rel.) at the variant C in compare with the untreated control (variant K), with the variant A + 1.07 $t.ha^{-1}$ (1.85 % rel.), and with the variant B + 3.97 $t.ha^{-1}$ (7.23 % rel.). In 2002, the increase of yield was statistically significant at the variant C in compare with K + 12.21 $t.ha^{-1}$ (19.00 % rel.), with the variant A + 1.89 $t.ha^{-1}$, (2.57 % rel.) and with the variant B + 7.71 $t.ha^{-1}$ (11.42 % rel.). In 2003, the increase of yield was statistically not significant at the variant C in compare with the variant K – 0.18 $t.ha^{-1}$ (99.64 % rel.), with the variant A + 0.88 $t.ha^{-1}$ (1.76 % rel.) and with the variant B – 1.53 $t.ha^{-1}$ (96.87 % rel.). In 2004, the increase of yield was statistically not significant and the highest increase of yield was at the variant C (compare with the variant K – 3.72 $t.ha^{-1}$ (92.24 % rel.), with the variant A – 4.75 $t.ha^{-1}$ (89.87 % rel.) and with the variant B – 2.84 $t.ha^{-1}$ (94.18 % rel.).

T a b l e 2

Variants of foliar treatment

Variant		Dose $l.ha^{-1}$	Term of application
K	untreated control	–	–
A	Atonik Atonik	0.6 0.6	2nd post-emergent herbicide application 3rd post-emergent herbicide application
B	Atonik Atonik + Polybor 150 Polybor 150	0.4 0.6 + 2.5 2.5	2nd post-emergent herbicide application 3rd post-emergent herbicide application 1st fungicide treatment
C	Atonik Atonik + Polybor 150 Atonik + Polybor 150	0.4 0.6 + 2.5 0.6 + 2.5	2nd post-emergent herbicide application 3rd post-emergent herbicide application 1st fungicide treatment

Sugar digestion

The average sugar beet digestion during the trial period of 2002–2004 was 19.59 %, the difference between maximum value (2004) and minimum value (2002) was 5.02 % (statistically highly significant). Positive differences of sugar beet digestion showed the determinative influence of weather conditions on sugar beet yield formation in the year with favourable weather conditions (sufficient amounts of precipitation and their regular distribution) (tab. 4).

There was found to be a significant influence of sugar beet varieties on sugar beet digestion (tab. 3). On average, higher digestion reached variety Swing (N – type) + 0.26 % (1.33 % rel.) in comparison with Flair (N/S – type) in the conditions of the warm corn-producing area. During the course of the trial period, the sugar beet digestion of variety Swing in comparison with Flair was as follows: – 0.03 % (99.82 % rel.) (2002), + 0.55 % (2.74 % rel.) (2003), + 0.25 % (1.15 % rel.) (2004). Variety effect on sugar beet digestion was highly significant in 2003, significant in 2004 and not significant in 2002.

Atonik and Polybor 150 treatments had a

Table 3

Analysis of variance for sugar beet root yield, digestion and refined sugar yield

Source of variability	Root yield ($t.ha^{-1}$)	Digestion (%)	Refined sugar yield ($t.ha^{-1}$)
	P – value		
Year	0.0000^{++}	0.0000^{++}	0.0000^{++}
Variety	0.2506^{-}	0.0033^{++}	0.3623^{-}
Leaf treatment	0.0039^{++}	0.0000^{++}	0.0000^{++}
Variety x treatment		0.0000^{++}	0.0388^{+}

$^{++}$statistically significant differences at the level $\alpha = 0.05$

Table 4

Sugar beet observed parameters reached by variety and different application during the years 2002–2004

Source	Root yield ($t.ha^{-1}$)	Digestion (° S)	Refined sugar yield ($t.ha^{-1}$)
Year			
2002	69.83b	16.70a	11.06c
2003	49.57a	20.33b	8.70a
2004	49.46a	21.73c	9.49b
Limits ($LSD_{0,05}$)	2.74	0.20	0.53
Variety			
Flair	56.94a	19.46a	9,83a
Swing	55.64a	19.72b	9,67a
Limits ($LSD_{0,05}$)	2.01	0.16	0,69
Application			
K (untreated control)	53.55a	19.09a	8.92a
A	57.81bc	19.57b	10.03bc
B	54.90ab	19.79bc	9.67b
C	58.89c	19.90c	10.39c
Limits ($LSD_{0,05}$)	3.16	0.23	0.68

a, b, c – homogenous groups (means followed by the same letter are not significantly different) high significant effect on sugar beet digestion. Maximum sugar digestion was at the variant C on average. The results of the variant C were compared with the variant K + 0.81 % (4.24 % rel.), with the variant A + 0.33 % (1.68 % rel.) and with the variant B + 0.11 % (0.55 % rel.).

The increase of sugar beet digestion at the variant C was in the years 2002 and 2004 (compare with the variant K: + 2.00 % (8.87 % rel.) and + 0.92 % (4.31 % rel.) respectively; with the variant A: + 0.36 % (2.14 % rel.) and + 0.75 % (3.48 % rel.) respectively; with the variant B: + 0.10 % (0.58 % rel.) and + 0.39 % (1.78 % rel.) respectively). In 2003, the sugar beet digestion at the variant C had following tendency: compare with the variant K – 0.16 % (99.21 % rel.), with the variant A + 0.08 % (0.39 % rel.), and with the variant B + 0.14 % (0.68 % rel.).

Refined sugar yield

The average refined sugar yield during the trial period was 9.74 $t.ha^{-1}$ with a deviation among the trial years 2.34 $t.ha^{-1}$. From the point of statistical analysis, presented differences are evaluated as statistically highly significant.

There was no significant effect on the varieties of the refined sugar yield (tab. 3). A higher yield of refined sugar achieved variety Flair in comparison with Swing (+ 0.16 $t.ha^{-1}$ (1.65 % rel.). These results are similar (statistically not significant) to the ones of 2003 and 2004 (+ 0.46 $t.ha^{-1}$ (5.43 % rel.) and + 0.16 $t.ha^{-1}$ (1.70 % rel.), respectively). The opposite situation occurred in 2002 (variety Swing in compare with Flair + 0.15 $t.ha^{-1}$ (1.27 % rel.), statistically not significant).

The application of biologically active compounds had a significant influence on the formation of the refined sugar yield. The highest increase was at the variant C in comparison with the variant K + 1.47 $t.ha^{-1}$ (16.49 % rel.), with the variant A + 0.36 $t.ha^{-1}$ (3.59 % rel.), and with the variant B + 0.72 $t.ha^{-1}$ (7.45 % rel.).

In the course of the trial years, the results were as follows:

- 2002: C/K + 3.04 $t.ha^{-1}$ (33.00 % rel.); C/A + 0.03 $t.ha^{-1}$ (0.24 % rel.); C/B + 1.95 $t.ha^{-1}$ (18.93 % rel.);
- 2003: K/A + 0.65 $t.ha^{-1}$ (7.42 % rel.); K/B + 0.96 $t.ha^{-1}$ (11.37 % rel.); K/C + 0.26 $t.ha^{-1}$ (2.84 % rel.);
- 2004: C/K + 1.05 $t.ha^{-1}$ (11.27 % rel.); C/A + 0.99 $t.ha^{-1}$ (10.56 % rel.); C/B + 1.13 $t.ha^{-1}$ (12.24 % rel.).

CONCLUSION

Experimental results confirmed a statistically high significant influence of weather conditions for a specific trial year and foliar application of biologically active compounds Atonik and Polybor 150 on sugar beet root yield formation, sugar digestion and refined sugar yield. The influence of variety (Swing and Flair) on root yield and refined sugar yield was not statistically significant but was statistically significant on sugar beet digestion.

Higher root yield (69.82 $t.ha^{-1}$) and refined sugar yield (11.04 $t.ha^{-1}$) were found in 2002. From the point of yield stability, better results reached Swing (root yield: 70.68 $t.ha^{-1}$; refined sugar yield: 11.11 $t.ha^{-1}$) and the variant C with applied compounds (root yield: 75.22 $t.ha^{-1}$; refined sugar yield: 12.25 $t.ha^{-1}$). Sugar beet digestion was significantly influenced by variety Swing (19.72 %) at the variant C (19.90 %) in the year 2004 (21.73 %).

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SÚHRN

V poľnom polyfaktorovom pokuse realizovanom v rokoch 2002–2004 na stredne ťažkej hnedozemi, v teplej kukuričnej výrobnej oblasti sme sledovali vplyv odrôd a variantov aplikácie Atoniku a Polyboru 150 na úrodu buliev, digesciu a úrodu rafinády.

V pokusoch sa prejavil vysoko preukazný vplyv poveternostných podmienok a aplikácie Atoniku a Polyboru 150 na formovaní sledovaných parametrov úrody. Ako najoptimálnejší sa v daných pôdnoklimatických podmienkach, z hľadiska získanej úrody, digescie a úrody rafinády ukázal variant C (Atonik: 0,4 $l.ha^{-1}$ – 2. postemergentná aplikácia herbicídov + Atonik + Polybor 150: 0,6 + 2,5 $l.ha^{-1}$ – 3. postemergentná aplikácia herbicídov + Atonik + Polybór 150: 0,6 + 2,5 $l.ha^{-1}$ – 1 fungicídne ošetrenie).

Celkovo významnejšie hodnoty úrody buliev a úrody rafinády boli pri odrode Flair (+ 1,28 $t.ha^{-1}$, resp. 0,22 $t.ha^{-1}$ v porovnaní so Swing) a digescie pri Swing (+ 0,26 % v porovnaní s Flair).

Kľúčové slová: cukrová repa, foliárne ošetrenie, úroda, digescia, úroda rafinády