Table 3: Yields of winter wheat [t.ha^{-1}]

Year	Soil cultivation	Ecological system	Integrated system	Mean
1991	Minimum	5.7	6.3	6.0
	Conventional	5.7	6.4	6.0
	Mean	5.7	6.3 a	6.0
1992	Minimum	6.1	6.3	6.2
	Conventional	6.2	6.3	6.3
	Mean	6.2	6.3	6.2
1993	Minimum	3.3	3.1	3.2
	Conventional	3.1	3.5	3.3
	Mean	3.2	3.3	3.3
1994	Minimum	6.6	7.0 a	6.8
	Conventional	6.8	6.9	6.8
	Mean	6.7	7.0 a	6.8
1995	Minimum	5.2	5.9 a	5.5
	Conventional	6.6 B	6.2 A	6.4 B
	Mean	5.9	6.0	6.0
1996	Minimum	6.1	6.6	6.4
	Conventional	6.1	6.8	6.5
	Mean	6.1	6.7	6.4
1997	Minimum	4.7	6.1 b	5.4
	Conventional	5.9 A	6.8	6.4 A
	Mean	5.3	6.5 b	5.9
1998	Minimum	5.2	7.3 a	6.3
	Conventional	6.3	7.0	6.6
	Mean	5.7	7.1 a	6.4
Mean	Minimum	5.4	6.1 b	5.7
	Conventional	5.8	6.2 a	6.0 B
	Mean	5.6	6.2 b	5.9

Legend:
Significance levels for comparison of systems: a is P≤0.05; b is P≤0.01;
Significance levels for comparison of soil cultivation: A is P≤0.05; B is P≤0.01.

INFLUENCE OF SOIL CULTIVATION AND FERTILIZATION ON QUALITATIVE CHARACTERISTICS OF SUGAR BEET BULBS

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Summary

Contents of sugar, alfa-amino nitrogen, sodium, potassium in bulbs of sugar beet and their influence on the calculated technological parameters (refined sugar yielding, refined sugar production, losses of sugar in molasses, coefficient of alkalinity) were investigated in four-year field experiment (1995 to 1998) under the minimal and conventional soil cultivation with fertilized (manure + inorganic fertilizers) and unfertilized treatments within each soil cultivation system. Achieved results confirmed strong relation between sugar beet quality and the course of meteorological conditions. System of soil cultivation significantly influenced content of sodium in sugar beet bulbs. Fertilization with manure + inorganic fertilizers negatively affected refined sugar yielding and losses of sugar in molasses.

Key words: sugar beet, technological quality, soil cultivation, fertilization

Introduction

Quality of sugar beet bulbs is influenced by a number of factors and their´s mutual interactions. The result of these interactions represents certain level of technological quality of bulbs which is a decisive criterion for economically effective processing of this raw material. Recently, new technological procedures have been introducing within sugar beet production focused to improving its technological parameters.

Katagi (1986) investigated effect of minimal soil cultivation on yields and sugar content in bulbs. He found out that minimal cultivation reduces yields and increses content of sugar, decreasing content of molasses-forming elements at the same time. Similar results were published by Muchová et al. (1998), Frančáková et al. (1996) and Pačuta (1996).
Nutrition of sugar beet in relation with course of weather influences strongly technological quality of bulbs. Cationic component of mineral substances and portion of monovalent and bivalent cations play important role in the process. Especially content of monovalent cations is important because in relation to alfa-amino nitrogen decisively influences coefficient of alkalinity (Nomura 1986, Chochola 1988, Bízik 1993).
Studying alternative systems of sugar beet production, a great attention was devoted to the utilization of manure. Kennedy (1993) concluded that high rates of manure decrease sugar content of bulbs in alternative cropping systems as well.
To test the effect of two different systems of soil cultivation and fertilization on sugar beet bulbs quality within integrated farming system was the aim of the work.

Material and methods

Within the integrated farming system four-year field experiment with sugar beet was established on brown clay loamy soil (tab. 1) on the experimental basis of Slovak Agricultural University in Nitra (48°19´N; 18°09´E). There were investigated two soil cultivation systems (minimal shallow cultivation into the depth of 0,15 m and conventional cultivation into the depth of 0,25 m) there. Within each cultivation system, two treatments of fertilization were applied: 1.) fertilization with the dose of 40 $t.ha^{-1}$ of manure+NPK inorganic fertilizers calculated on the basis of balance and diagnostic method 2.) unfertilized treatment.

Table 1 Agrochemical charakteristics of soil (into the depth of 0.4 m)

Year	Site N°	Soil reaction pH/ KCl	Oxidizable carbon (C_{ox})	Humus content (%)	Inorg. N Nin ($mg.kg^{-1}$)	Available nutrients ($mg.kg^{-1}$)		
						P	K	Mg
1995	4	5,81	1,15	1,98	8,13	67	200	150
1996	7	5,75	1,17	2,02	16,1	98	435	190
1997	1	5,80	1,26	2,17	10,9	88	300	175
1998	8	5,93	1,20	2,06	31,9	86	410	232

Inorganic and easy hydrolyzable nitrogen was analysed in soil. Because of the relatively high supply of nutrients in soil (tab. 1) low rates of essential inorganic nutrients were applied within the sugar beet pattern of fertilization. In crop rotation, sugar beet (variety Intera) followed winter wheat. Each experimental plot (combination of experimental factors) was four times replicated. Sugar beet was harvested in the stage of technological maturity at the beginning of October. Within the chemical analyses the following characteristics were determined: content of sugar (° S)-polarimetrically, content of Na, K and alfa-amino nitrogen ($mmol.100g^{-1}$)-spectrophotometrically. On the basis of these analytical values, the other technological parameters were calculated according to Reinefeld et al. (1974) including refined sugar yielding (%), losses of sugar in molasses (%), coefficient of alkalinity and refined sugar production ($t.ha^{-1}$). This trial was integral part of the research project VEGA GP 1/2081/95 in which the field experiments of integrated and ecological farming system were realized and researched (Lacko-Bartošová, Antala 1996).

Results and discussion

Strong effect of weather conditions on the qualitative parameters of sugar beet bulbs results from the analysis of variance (tab. 2). All investigated characteristics were influenced by this factor highly significantly. This finding is in accordance with the results achieved by Muchová et al. (1998).

Table 2 Analysis of variance of experimental factors on the variability of investigated characteristics

Characteristic		Sugar (°S)	K	Na	α N	Yielding of sugar (%)	Losses of sugar (%)	Coef. of alkalinity	Prod. of sug.($t.ha^{-1}$)	Yields of bulbs $t.ha^{-1}$
			mmol.$100g^{-1}$							
Source of var.	df	Calculated F-values								
Cultivation	1	0,57	0,19	4,9*	0,48	0,67	0,10	1,41	25,8**	35,7**
Fertilization	1	3,52	3,4	1,0	2,46	5,88*	4,21*	0,29	0,012	1,56
Years	3	14**	74**	15**	**	4,44**	97,6**	102**	14,7**	12,3**
Cult. x Fertil.	1	0,4	0,0	0,32	0,55	0,47	0,33	2,47	18,5**	19,5**

df – degree of freedom * significant effect ** highly significant effect

Soil cultivation showed statistically significant effect on sodium content in bulbs (tab. 2, 3). Lower Na content was analysed in bulbs under minimal cultivation (0,52 $mmol.100g^{-1}$) comparing with conventional system (0,59 $mmol.100g^{-1}$). Frančáková et al. (1996) states decrease of this element content in bulbs by 15,1 % as a consequence of minimal soil tillage. Similar tendency was also observed with alfa-amino N, but without statistical significance. As to the potassium, minimal soil cultivation increased potassium content in bulbs (not significantly).
Fertilization as the second investigated factor showed no significant effect on the contents of these elements in sugar beet. However, there was a tendency to reduce their content in bulbs under the unfertilized treatment (Katagi 1986).
Content of sugar was higher under minimal soil cultivation (17,16 °S), but not statistically significant comparing with conventional soil tillage (17,04 °S). Fertilization was not significant, but there was tendency to increase sugar content under unfertilized treatment (17,24°S) versus fertilized one (16,96 °S). Similar results were achieved by Kováčová (1999) and Pačuta (1996).
Soil cultivation statistically influenced neither refined sugar yielding nor both losses of sugar in molasses and coefficient of alkalinity. Effect of fertilization was negative and decrease the values of sugar yielding and contrarily increase the losses in molasses (not significantly).

Table 3 Significance of mean characteristic differences between levels of investigated experimental factors (LSD-test)

Characteristic	Level of	Sugar	K	Na	αN	YS	LS	CA	PS	YB
Source of var.	factor	Mean								
Soil cultivation	MIN	17,16a	5,97a	0,52a	5,25a	14,15a	2,41a	1,35a	6,33a	44,70a
	CON	17,04a	5,92a	0,59b	5,34a	14,02a	2,42a	1,31a	7,38b	52,55b
Limit diff. (0,05)		0,302	0,225	0,064	0,256	0,317	0,098	0,065	0,415	2,635
Limit diff. (0,01)		-	-	-	-	-	-	-	0,553	3,509
Fertilization	manure+N PK	16,96a	6,05a	0,57a	5,39a	13,89a	2,47a	1,32a	6,87a	49,45a
	unfertilized	17,24	5,84a	0,54a	5,19a	14,28b	2,37b	1,34a	6,84a	47,81a
Limit diff. (0,05)		0,302	0,225	0,064	0,256	0,317	0,098	0,065	0,415	2,635

YS-refined sugar yielding LS-losses of sugar in molasses CA-coefficient of alkalinity
PS-refined sugar production YB-yields of sugar beet bulbs

Conventional soil cultivation showed strong statistically significant effect on refined sugar production (7,38 $t.ha^{-1}$) in comparison to minimal cultivation (6,33 $t.ha^{-1}$). Fertilization was not significant in this parameter. There was also found out highly significant interactions between soil cultivation and fertilization (tab. 2). In this connection, important role was played by the yields of sugar beet bulbs which levels were strongly effected by conventional cultivation and slightly by fertilization (tab. 3).

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