

IMPACT OF SOWING DEPTH AND SEEDBED ROLLING ON SUGAR BEET

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Abstract

The trial was conducted on a silty loam *LVg-p-w-cc(sc)-Calc(ar)i-Epihypogleyic Luvisol* at the Experimental Station of the Lithuanian University of Agriculture in 2004, 2005, 2007. The aim of investigations was to determine the influence of sugar beet (*Beta vulgaris* L.) sowing depth and seedbed rolling methods on sugar beet seed field germination, root yield and quality. Two factors were investigated: sowing depth ranging from shallow to deep (factor A) and seedbed rolling methods (factor B). Cambridge and spur rollers were used pre- and post-sowing.

Our experimental evidence suggests that an increase in soil tillage depth reduced sugar beet seed field germination, crop density, root yield and quality. Sugar beet seedbed pressure by a Cambridge roller after sowing resulted in a better sugar beet seed germination. However, the influence of seedbed rolling on root yield and quality was not completely clear. Seed germination and crop density were found to exert the greatest effect on sugar beet root yield and quality.

Key words: sugar beet, sowing depth, seedbed rolling, seed germination, yield, root quality.

Introduction

The germination of sugar beet seeds is still problematic because of lower seed energy, therefore, careful formation of seedbed is required /Draycott, 2006/. In Lithuania, the optimal depth for sugar beet seed sowing is about 19–39 mm /Romaneckas et al., 2001; Romaneckas et al., 2002/, but many farmers sow too deeply, which results in delayed germination and formation of uneven and thin crop. Rolling of soil before or after sowing is not necessary every year. Soil rolling is useful if tillage implements have tilled the soil too deeply /Draycott, 2006/ or there are more than 5% of clods on the soil surface and they are bigger than 50 mm /Žulienė, 1978; Dürr et al., 2001/. Soil rolling is especially useful in dry spring, as having got to the dry soil layer, seeds need more time to swell and their germination is uneven. In this case, rolling improves the initial consolidation, increases capillary moisture movement which is necessary for seed germination (18–22%) /Romaneckas et al., 2001; Håkansson et al., 2002/. In the lightest and heaviest soils rolling reduces evaporative water losses. Conversely, rolling increases

water losses in the intermediate textured soils /Håkansson et al., 2002/. In field trials with rolling after spring sowing of barley, oats and wheat, Scandinavian scientists established positive effect of rolling on early crop emergence by 9%, final emergence by 2% and yield by 2% /Håkansson et al., 2002/. In other trials soil rolling increased soil compaction and thus negatively affected maize emergence, plant height and root growth /Kayombo, Lal, 1986/. Besides, an increase in soil penetration resistance of 700 kPa resulted in a 10% reduction in sugar beet sucrose yield /Anderson, Peterson, 1985/. However, soil rolling can affect time of emergence but not final germination /Atkinson et al., 2007/. Therefore, in wet situation soil rolling may have negative influence because it destroys soil structure and increases soil bulk density, which results in soil crust formation /Stenberg et al., 1994/. Velykis and Satkus (2005) established strong negative correlation between mass of crust and structural coefficient ($r = -0.783^{**}$). However, the compacting effect of rainfall can be greater than the effect of rolling /Słowińska-Jurkiewicz, 1994/.

As a result, soil rolling is risky and depends on soil moisture content and precipitation regime till seed germination. The importance of soil rolling for sugar beet has not been comprehensively investigated in Lithuania yet. The aim of the present study was to determine the possibility to improve sugar beet seedbeds of different depths, root yield and quality by soil pressure before or after sowing.

Materials and methods

Site and treatments. The investigations were carried out in 2004, 2005 and 2007 on a silty loam *LVg-p-w-cc(sc)-Calc(ar)i-Epihypogleyic Luvisol* at the Experimental Station of the Lithuanian University of Agriculture. The soil was of slightly alkaline or neutral reaction ($\text{pH}_{\text{KCl}} 7.0\text{--}7.2$), medium rich in humus (2.1–2.3%), rich in phosphorus (280 mg kg^{-1}) and medium rich in potassium (129 mg kg^{-1}).

The field experiment was arranged according to the following design: I. Sowing depth (factor A): 1) 2.1–3.0 cm (shallow), 2) 3.1–4.0 cm (moderate), 3) 4.1–5.0 cm (deep). II. Soil rolling methods (factor B): 1) not rolled (control) (N), 2) rolled by a Cambridge roller before sowing (CRB), 3) rolled by a spur roller before sowing (SRB), 4) rolled by a Cambridge roller after sowing (CRA), 5) rolled by a spur roller after sowing (SRA).

The initial size of the trial plot was 9–12 m^2 . The fore crop of sugar beet was winter wheat. The space between the rows of sugar beets was 0.45 m, the distance between seeds 0.11–0.14 m. The soil was loosened with a complex cultivator before sowing at different depths according to the experimental design. Forming different depth backgrounds of pre-sowing soil tillage, the plots were rolled across. Fertilisation rate was NPK 11:13:30 450 kg ha^{-1} (N_{50} , P_{59} , K_{135}). The additional fertilisation was N_{60} . Chemical control of weeds and insects was applied.

Characteristics of implements. Before and shortly after sowing the soil was pressed with a complex roller KKN-2.8 (Cambridge roller) (Fig. 1 a). The working width of the roller was 2.8 m, mass per meter of working width – 256.4 kg. In other plots the soil was pressed with a spur roller 3KKŠ-6 (Fig. 1 b), with a working width of 6.0 m (only one section of the three was used; working width 2.0 m) and mass per meter of working width 300.8 kg.

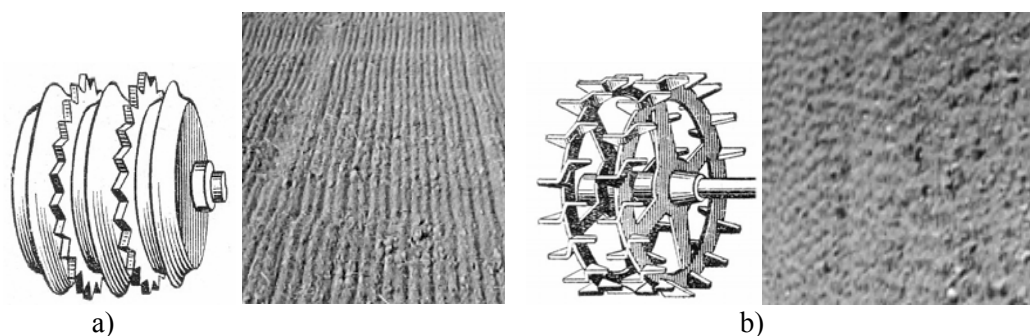


Figure 1. Working parts of rolls and surface of the seedbed formed by them: a) flat and toothed discs (Cambridge roller) and soil rolled by it, b) discs with spurs (spur roller) and soil rolled by it

1 paveikslas. Volų darbinės dalys ir jais suformuotos sėklų guoliavietės paviršius: a) lygūs ir dantyti diskai (Kembridžo volas) ir juo suvaluota dirva, b) diskai su pentiniais (pentininis volas) ir juo suvaluota dirva

Methods. The indices of sugar beet seedbed were determined by Kritz method /Kritz, 1983; Håkansson et al., 2002/. Gravimetric water content (mass wetness) /Hillel, 1982/ was determined by the weighing method. Seed field germination was determined having counted the plants that sprouted in all plots, productivity – having weighed the washed roots of sugar beets. Crop density before harvesting was established by counting all plants per plot. The fanging of sugar beet roots was estimated by counting fanged roots per sample and recalculated into percent. The height of sugar beet root-crop over the soil was determined by measuring not less than 50 plants per plot. Analyses of sugar beet root quality were done in the laboratory of the Kėdainiai Sugar Factory (‘Danisco Sugar Kedainiai’) by express methods.

The trial data were analysed by *Anova*. The treatment effects were tested by the least significant differences LSD_{05} , P and F tests. Each year the data were analysed separately. The trial data were also evaluated using correlation and regression analysis by *SigmaPlot 8.0* software.

Weather data. The weather conditions of the sugar beet growing seasons during the experimental period are presented in Table 1.

In 2004, sugar beet seed germination conditions were dry (7.4 mm of precipitation during 19 days), therefore soil pressure was useful. In 2005, the soil was wet and rolling was risky. In 2007 soil conditions before spring tillage and after sowing were dry and soil rolling was desirable like in 2004.

Table 1. The air temperatures and rainfall during the sugar beet growing seasons (Kaunas Weather Station data)

1 lentelė. Oro temperatūra ir krituliai cukrinių runkelių vegetacijos metu (Kauno meteorologijos stoties duomenys)

2004, 2005, 2007

Month <i>Mėnuo</i>	April <i>Balandis</i>	May <i>Gegužė</i>	June <i>Birželis</i>	July <i>Liepa</i>	August <i>Rugpjūtis</i>	September <i>Rugsėjis</i>	October <i>Spalis</i>
2004							
Temperature °C <i>Temperatūra °C</i>	7.4	11.0	14.2	16.6	17.9	12.7	8.3
Rainfall mm <i>Krituliai mm</i>	15.1	38.3	62.9	78.5	98.0	35.3	80.7
2005							
Temperature °C <i>Temperatūra °C</i>	7.5	12.1	15.0	19.0	16.7	14.2	8.0
Rainfall mm <i>Krituliai mm</i>	37.4	76.9	78.1	45.4	136.2	46.5	10.8
2007							
Temperature °C <i>Temperatūra °C</i>	7.0	13.6	17.8	17.1	18.5	12.8	7.6
Rainfall mm <i>Krituliai mm</i>	22.2	96.5	70.0	148.7	78.6	41.5	56.7
Average / <i>Vidurkis 1974–2007 m.</i>							
Temperature °C <i>Temperatūra °C</i>	6.7	12.6	15.6	17.6	17.1	12.2	7.1
Rainfall mm <i>Krituliai mm</i>	38.1	47.2	66.7	83.0	73.2	53.8	54.8

Results and discussion

Seed germination and crop density. In 2004, sugar beet seed germination significantly depended on sowing depth (F-act. 16.98**) and seedbed rolling methods (F-act. 9.9**) (Table 2). Significantly highest sugar beet germination (63.5%) was observed after shallow seedbed pressure by a Cambridge roller after sowing (CRA). This trend was observed in our earlier investigations /Romaneckas et al., 2003/. The increase of sowing depth and seedbed rolling before sowing showed negative and significant influence on seed germination. The seed germination mostly depended on the sowing depth ($r = -0.563^*$, $Y = 77.46 - 0.78 x$) (Figure 2 a) and gravimetric moisture content in the seed zone ($r = 0.574^*$, $Y = 7.46 + 3.112 x$) (Figure 2 b). Durant (1988) reported similar conclusions. As a result, soil water content of the seedbed is the main factor, which influences crop seed germination /Arvidsson, Bölenius, 2006/.

Table 2. Seed germination (%) and crop density before harvesting (thousand plants ha⁻¹)
2 lentelė. Sėklų sudygimas (%) ir pasėlio tankumas prieš derliaus nuėmimą (tūkst. augalų ha⁻¹)

Soil rolling method (factor B) <i>Dirvos sutankinimo būdai (B veiksnys)</i>	Sowing depth (factor A) / Sėjos gylis (A veiksnys)								
	shallow / sekus			moderate / vidutinis			deep / gilus		
	2004	2005	2007	2004	2005	2007	2004	2005	2007
Seed germination / Sėklų sudygimas									
N	52.5	69.7	62.1	51.5	64.4	59.8	42.4*	72.1	57.1
CRB	50.6	63.5*	60.4	50.3	55.8**	52.4*	40.0**	68.4	56.6
SRB	55.2	67.8	55.2	48.0	62.5*	56.2	39.4**	68.2	55.0
CRA	63.5*	68.3	66.2	59.0	63.6*	56.6	51.3	68.9	43.4*
SRA	56.4	70.6	59.1	59.0	57.4**	52.3*	54.4	68.5	48.4*
LSD _{05 A x B} <i>R_{05 A x B}</i>							8.28	5.91	8.51
LSD _{01 A x B} <i>R_{01 A x B}</i>							11.06	7.90	11.38
Crop density / Pasėlio tankumas									
N	75.9	82.1	83.1	73.5	82.1	74.9	31.5**	70.6	73.2
CRB	57.4*	86.6	89.7	73.9	69.7	69.1	30.2**	63.6	88.9
SRB	78.2	58.8	74.7	75.3	52.9*	78.4	27.3**	61.7	76.5
CRA	84.6	78.2	93.0	76.5	89.3	83.1	38.9**	71.6	70.0
SRA	78.7	75.9	78.4	81.5	79.3	64.8	28.2**	54.0*	74.1
LSD _{05 A x B} <i>R_{05 A x B}</i>							13.74		19.35
LSD _{01 A x B} <i>R_{01 A x B}</i>							18.53		26.10

Note. N – unrolled, CRB – rolled by a Cambridge roller before sowing, SRB – rolled by a spur roller before sowing, CRA – rolled by a Cambridge roller after sowing, SRA – rolled by a spur roller after sowing; * – significant difference from the control treatment at 95%, ** – at 99% probability level. Control treatment – shallow sowing, unrolled.

Pastaba. N – nevoluota, CRB – voluota Kembridžo volu prieš sėją, SRB – voluota pentininiu volu prieš sėją, CRA – voluota Kembridžo volu po sėjos, SRA – voluota pentininiu volu po sėjos; * – skirtumas esminis esant 95 %, ** – 99 % tikimybės lygiui. Kontrolinis variantas – sekli sėja, nevoluota.

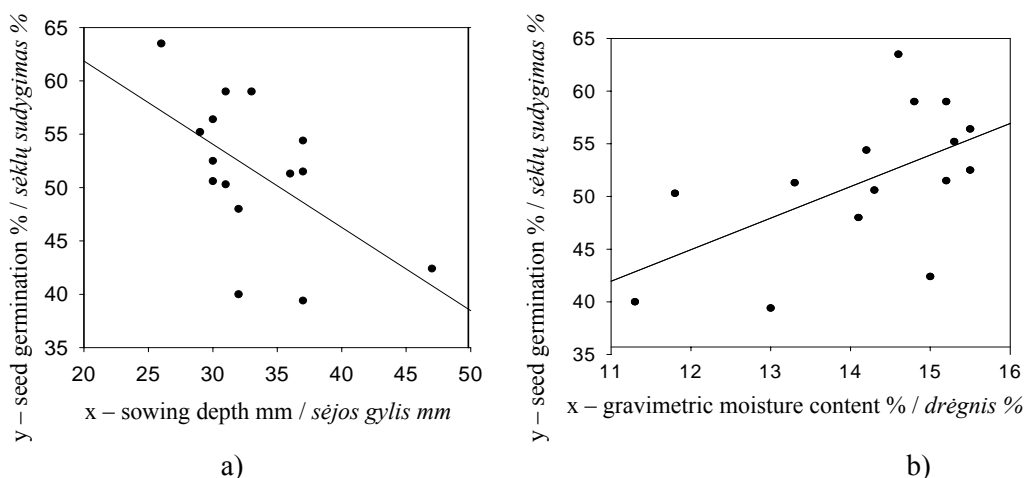


Figure 2. Sugar beet seed germination as affected by: a) sowing depth, b) soil gravimetric moisture content

2 paveikslas. Cukrinių runkelių sėklų sudygimo priklausomumas nuo: a) sėjos gylio, b) dirvos drėgnio

2004

In 2005, the increase of sowing depth and additional pressure of seedbed had mostly negative significant influence on seed germination because of wet soil conditions during the rolling operation (Table 2). Seed germination depended on the amount of seedbed structure fraction of 2–5 mm in size ($r = 0.493$, $Y = 42.399 + 0.728 x$) in seed zone (Figure 2). An increase in small soil aggregate fraction in seedbed exerted a positive effect on seed germination because of better initial consolidation and less moisture evaporation /Håkansson, Von Polgár, 1984; Heinonen, 1985; Gummerson, 1989; Aubertot et al., 1999; Håkansson et al., 2002/. The degree of soil-seed contact increases as macro porosity decreases /Brown et al., 1996/. We also observed this tendency in 2007 ($r = 0.42$, $Y = 39.866 + 0.4 x$) (Figure 3 a). In 2007, sowing depth had a greater influence on seed germination than seedbed pressure. The lowest seed germination was observed in deeply formed seedbeds rolled after sowing. However, like in 2004, the highest positive, but not significant, effect (4.1% units) was observed in the shallowly formed seedbeds rolled by a Cambridge roller after sowing. Like in 2004, in 2007 seed germination mostly depended on gravimetric moisture content in seed zone ($r = 0.785^{**}$, $Y = 28.255 + 1.842 x$) (Figure 3 b).

Pressing of seedbed deeper soil layers had no significant effect on seed germination because of light influence of rolls on soil compaction.

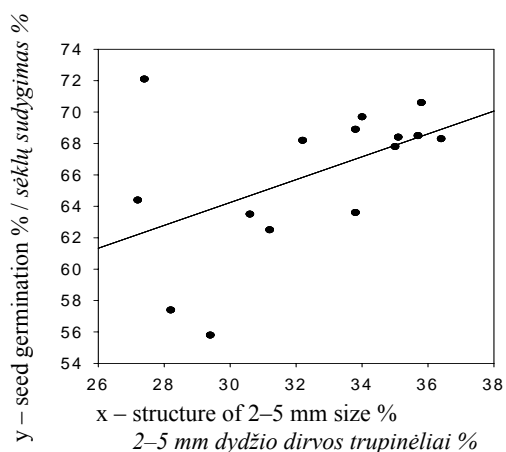
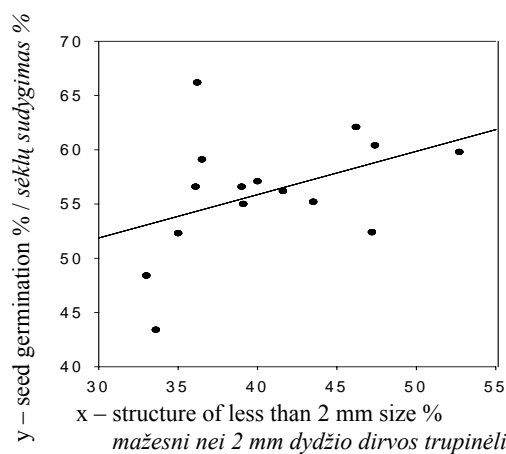


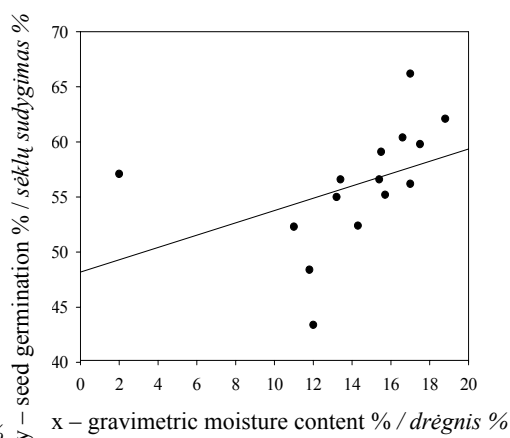
Figure. 3. Sugar beet seed germination as affected by seedbed structural aggregates of 2–5 mm in size

3 paveikslas. Cukrinių runkelių sėklų sudygimo priklausomumas nuo 2–5 mm dydžio sėklų guoliavietės struktūrinių trupinėlių

2005



a)



b)

Figure. 4. Sugar beet seed germination as affected by: a) seedbed structural aggregates < 2 mm in size, b) soil gravimetric moisture content

4 paveikslas. Cukrinių runkelių sėklų sudygimo priklausomumas nuo: a) <2 mm dydžio sėklų guoliavietės struktūrinių trupinėlių, b) dirvos drėgnio

2007

Lower seed germination in some pressed and deeper formed seedbeds exerted a negative effect on crop density before harvesting, especially in 2004 (Table 2). Higher crop density depended on better seed germination ($r_{2004} = 0.726^{**}$, $Y = -60.346 + 2.349 x$; $r_{2007} = 0.709^{**}$, $Y = 20.331 + 1.031 x$).

Root yield and morphometric parameters. In 2004 the sugar beet root yield depended more on sowing depth (F-act. 25.45**) than on soil rolling methods. Generally, seedbed pressure had a negative or similar effect on root yield (Table 3). The highest negative effect of seedbed pressure was observed in deeply formed seedbeds. In 2005, we observed similar but clearer results like in 2004. In 2007, both factors had significant influence (F-act. 9.05** and 2.75*) on root yield. The highest yield effect (11 t ha⁻¹) in comparison with the control treatment was established in deeply formed seedbed compressed by a Cambridge roller before sowing (CRB). However, according to the average data of factor B, the highest positive effect of seedbed rolling was observed after seedbed pressing shortly after sowing by a Cambridge roller (CRA) (data are not presented). In 2004–2005 root yield mostly depended on crop density ($r_{2004} = 0.876^{**}$, $Y = 36.163 + 0.339 x$; $r_{2005} = 0.34$, $Y = -1.732 + 0.574 x$). Such tendency was also observed by other researchers /Märländer, 1990; Romanekas et al., 2006; Koch et al., 2009/. These data show that in 2004–2005 the variation of crop density was higher than in 2007.

Table 3. Root yield (t ha⁻¹), height of the above-ground part (cm) and root fanging (%)
3 lentelė. Šakniavaisių derlingumas (t ha⁻¹), antžeminės dalies aukštis (cm) ir šakotumas (%)

Soil rolling methods (factor B) <i>Dirvos sutankinimo būdai</i> (B veiksnys)	Sowing depth (factor A) / <i>Sėjos gylis</i> (A veiksnys)								
	shallow <i>seklus</i>			moderate <i>vidutinis</i>			deep <i>gilus</i>		
	2004	2005	2007	2004	2005	2007	2004	2005	2007
1	2	3	4	5	6	7	8	9	10
Yield / <i>Derlingumas</i>									
N	61.9	73.4	59.3	69.3	29.8**	52.2	49.6*	30.7**	62.2
CRB	59.3	71.0	58.2	61.2	26.8**	60.7	47.6*	26.9**	70.3*
SRB	63.0	66.5	58.0	62.0	26.3**	58.4	37.8**	22.5**	66.0
CRA	59.4	67.8	61.8	59.3	28.1**	63.7	55.2	28.6**	65.1
SRA	59.1	44.0**	52.3	64.4	24.7**	52.5	42.2**	25.1**	63.9
LSD _{05 A x B}							11.56	21.09	9.67
R _{05 A x B}									
LSD _{01 A x B}							15.60	28.44	13.05
R _{01 A x B}									
Height / <i>Aukštis</i>									
N	4.6	5.3	5.2	3.8	1.9**	5.2	5.4	2.0**	5.3
CRB	4.0	4.4	5.0	3.4	2.0**	5.6	5.2	1.8**	5.5
SRB	4.0	4.0	6.1	3.8	1.8**	5.8	6.6*	2.4**	5.7
CRA	4.4	4.8	5.2	4.4	2.0**	5.0	5.2	1.8**	5.7
SRA	5.4	4.2	5.8	3.8	2.2**	5.3	5.2	3.0**	5.8
LSD _{05 A x B}							1.58	1.46	1.71
R _{05 A x B}									
LSD _{01 A x B}							2.20	2.02	2.37
R _{01 A x B}									

Table 3 continued
3 lentelės tęsinys

1	2	3	4	5	6	7	8	9	10
Fanging / Šakotumas									
N	12.3	11.2	27.7	11.7	5.4	46.2*	17.4	14.9	35.4
CRB	11.9	3.3	25.3	7.5	10.8	49.9**	27.5**	14.6	37.5
SRB	8.9	27.9*	33.9	8.0	3.7	56.1**	25.1*	16.0	39.2
CRA	7.1	20.1	22.2	7.2	6.3	40.4	15.5	18.9	44.9*
SRA	5.1	14.5	27.6	8.6	7.5	44.4*	14.7	22.9	39.5
LSD _{05 A x B}							11.10	14.91	14.54
R _{05 A x B}									
LSD _{01 A x B}							14.98	20.11	19.62
R _{01 A x B}									

Explanation under Table 2 / Paaiškinimai po 2 lentelės.

The height of root is an important factor influencing harvesting quality /Romaneckas, 1998/. In 2004 the height of root mostly depended on the sowing depth (F-act. 13.37**). The increase of sowing depth increased the height of root (Table 3). In deeply formed seedbeds pressed by a spur roller before sowing (SRB) sugar beet roots were the highest (6.6 cm). In 2005, we observed the converse effect. In 2007, both factors had no significant effect on root height.

The height of root mostly depended on crop density if the variation of this index was high (from 30 to 80 thousand plants m⁻²) /Romaneckas, 2004/. We observed this influence in 2004, 2007 ($r_{2004} = -0.722^{**}$, $Y = 6.302 - 0.028 x$; $r_{2007} = -0.412$, $Y = 6.814 - 0.017 x$). In our trial the height of root mostly depended on the amount of small soil structural aggregates (2–5 mm) in deeper seedbed layers ($r_{2004} = 0.583^{*}$, $Y = -0.753 + 0.148 x$; $r_{2005} = 0.528^{*}$, $Y = 1.059 + 0.136 x$). According to other investigations, the height of seedlings of sugar beet increases if the sun radiation in the soil during seed germination is low. Fraction of small aggregates forms such conditions /Romaneckas, 1998/.

Root fanging influences yield and quality loss /Draycott, 2006/. In 2004, the sowing depth significantly increased root fanging (F-act. 14.3**). The highest root fanginess was determined in deeply formed seedbeds pressed before sowing (Table 3). In 2005 and 2007 we observed similar but not so clear influence. In our trial root fanginess mostly depended on crop density ($r_{2004} = -0.862^{**}$, $Y = 27.887 - 0.252 x$; $r_{2005} = -0.495$, $Y = 35.599 - 0.312 x$; $r_{2007} = -0.63^{*}$, $Y = 96.393 - 0.747 x$) and on the amount of small (< 2 mm and 2–5 mm) soil aggregates in deeper layers of the seedbed ($r_{2004 < 2 \text{ mm}} = 0.647^{**}$, $Y = -4.188 + 0.846 x$; $r_{2004 2-5 \text{ mm}} = 0.593^{*}$, $Y = -30.704 + 1.356 x$).

Root quality. In 2004 sucrose content in the roots strongly depended on the sowing depth and seedbed rolling methods. According to the average data of trial's separate factors, the increase of sowing depth decreased sucrose content in the roots, and seedbed pressure showed converse results (Table 4). Sowing depth had significant influence only in 2005. In 2007, all factors had no influence. According to the data of other investigations, sucrose content in roots strongly depended on crop density /Žulienė, 1978/. We observed this tendency only in 2004 because of the high variation of

crop density ($r = 0.829^{**}$, $Y = 16.052 + 0.02 x$). In 2004, we calculated the influence of height and root fanging (x) on sucrose content (Y) ($r = -0.539^*$, $Y = 18.793 - 0.334 x$; $r = -0.865^{**}$, $Y = 18.139 - 0.071 x$). These data mean that roots with large height and fanging percentage are of poorer quality.

Table 4. Sucrose (g kg^{-1}), potassium ($\text{mmol } 100 \text{ g}^{-1}$) and α -amino N ($\text{mg } 100 \text{ g}^{-1}$) content in sugar beet roots

4 lentelė. Sacharozės (g kg^{-1}), kalio ($\text{mmol } 100 \text{ g}^{-1}$) ir α -amino N ($\text{mg } 100 \text{ g}^{-1}$) kiekis cukrinių runkelių šakniavaisiuose

Soil rolling methods (factor B) <i>Dirvos sutankinimo būdai (B veiksnys)</i>	Sowing depth (factor A) / <i>Sėjos gylis (A veiksnys)</i>								
	shallow <i>seklus</i>			moderate <i>vidutinis</i>			deep <i>gilus</i>		
	2004	2005	2007	2004	2005	2007	2004	2005	2007
Sucrose / <i>Sacharozė</i>									
N	174.7	166.9	160.0	172.7	171.9	163.6	162.1**	156.4**	161.7
CRB	177.1	167.6	159.4	172.4	170.3	163.1	163.4**	159.4*	161.6
SRB	176.1	166.7	163.9	174.4	170.5	166.2	165.1**	157.2**	164.2
CRA	176.7	171.3	167.0	176.0	170.2	172.9*	171.1	161.5	163.9
SRA	179.7	169.4	163.3	175.7	169.1	165.5	171.1	162.6	161.7
LSD _{05 A x B}							5.08	5.58	10.40
$R_{05 A x B}$									
LSD _{01 A x B}							6.86	7.52	14.03
$R_{01 A x B}$									
Potassium / <i>Kalis</i>									
N	4.6	4.5	4.0	4.7	3.3	4.1	5.3**	3.5	4.4
CRB	4.5	4.1	4.1	4.7	3.4	4.2	5.4**	3.6	4.4
SRB	4.5	4.0	4.0	4.6	3.6	4.2	5.2**	3.7	4.3
CRA	4.5	3.9	3.8	4.5	3.2*	4.3	4.9	3.3*	4.4
SRA	4.3	2.6**	4.1	4.4	3.2*	4.2	5.1*	3.6	4.3
LSD _{05 A x B}							0.37	1.16	0.48
$R_{05 A x B}$									
LSD _{01 A x B}							0.50	1.57	0.65
$R_{01 A x B}$									
α -amino N / <i>α-amino N</i>									
N	8.0	11.9	30.5	9.7	6.2*	24.9	13.7**	7.8	24.3
CRB	7.8	8.7	32.2	9.3	6.3*	28.5	13.5**	7.1*	26.5
SRB	8.3	7.7	33.6	9.8	6.7*	27.0	15.8**	10.8	26.1
CRA	8.0	6.9*	27.7	10.1	6.0*	25.3	13.3**	7.0*	26.4
SRA	7.6	5.3**	29.5	9.4	5.2**	24.8	10.9*	7.3*	25.2
LSD _{05 A x B}							2.91	4.44	7.30
$R_{05 A x B}$									
LSD _{01 A x B}							3.93	5.99	9.84
$R_{01 A x B}$									

Explanation under Table 2 / *Paaiškinimai po 2 lentele.*

In 2004, sowing depth and seedbed rolling methods had significant effect on potassium content in roots (Table 4). The increase of sowing depth increased potassium content in roots and seedbed rolling-decreased. We did not observe the effect of all factors in 2005. In 2007, the increase of sowing depth significantly increased only potassium content. The amount of potassium in the roots depended on crop density ($r_{2004} = -0.918^{**}$, $Y = 5.633 - 0.014 x$), root fanginess ($r_{2004} = 0.896^{**}$, $Y = 4.149 + 0.048 x$; $r_{2007} = 0.559^*$, $Y = 3.812 + 0.01 x$) and sucrose content ($r_{2004} = -0.967^{**}$, $Y = 15.779 - 0.639 x$).

The content of α -amino nitrogen in roots significantly depended on the sowing depth (Table 4). In 2004, the effect was positive and in 2005, in 2007 it was negative. In 2005, we observed negative effect of seedbed compressing too. According to the calculations, the content of α -amino nitrogen depended on crop density ($r_{2004} = -0.842^{**}$, $Y = 16.169 - 0.096 x$) (as shown by Märländer, 1990), height of root ($r_{2004} = 0.627^*$, $Y = 3.571 + 0.257 x$; $r_{2005} = 0.532^*$, $Y = 3.018 + 0.187 x$), root fanging ($r_{2004} = 0.896^{**}$, $Y = 4.149 + 0.048 x$), sucrose content in roots ($r_{2004} = -0.967^{**}$, $Y = 15.779 - 0.639 x$; $r_{2005} = -0.427$, $Y = 32.464 - 1.51 x$) and potassium content in roots ($r_{2004} = 0.885^{**}$, $Y = -20.044 + 6.392 x$; $r_{2005} = 0.77^{**}$, $Y = -4.105 + 3.229 x$).

Conclusions

1. The best sugar beet seed germination was established in shallowly formed seedbeds pressed by a Cambridge roller after sowing (CRA). The positive influence of seedbed pressure was observed in dry spring (2004, 2007) conditions. Seed germination mostly depended on sowing depth, water content and amount of small (< 2 mm, 2–5 mm in size) soil aggregates in the seedbed.

2. Lower seed germination in some rolled and deeper formed seedbeds negatively affected crop density before harvesting. Crop density depended on seed germination ($r_{2004} = 0.726^{**}$, $r_{2007} = 0.709^{**}$) when the variation of germination was from 39 to 66%.

3. In 2004–2005, seedbed pressure had negative or similar effect on root yield due to the dry conditions of the growing season in 2004 and due to the wet conditions at rolling in 2005. The highest negative effect of seedbed pressure was observed in deeply formed seedbeds. In 2007, the highest yield (11 t ha⁻¹) in comparison with the control treatment (N) was established in deeply formed seedbed pressed by a Cambridge roller before sowing (CRB). Root yield mostly depended on crop density ($r_{2004} = 0.876^{**}$, $r_{2005} = 0.34$).

4. The height of root depended more on the amount of small soil structural aggregates (2–5 mm in size) in deeper layers of the seedbed ($r_{2004} = 0.583^*$, $r_{2005} = 0.528^*$) than on seedbed depth and its pressing.

5. The highest root fanginess was observed in deeply formed seedbeds pressed before sowing. The root fanging mostly depended on crop density ($r_{2004} = -0.862^{**}$, $r_{2005} = -0.495$, $r_{2007} = -0.63^*$) and on the amount of small (< 2 mm and 2–5 mm size) soil aggregates in deeper layers of the seedbed ($r_{2004 < 2 \text{ mm}} = 0.647^{**}$, $r_{2004 2-5 \text{ mm}} = 0.593^*$).

6. The influence of sowing depth and seedbed rolling methods on sugar beet root quality was not clear in each year of the trial. Generally, the increase of sowing depth had negative and seedbed pressing – positive influence on root quality. Root quality mostly depended on crop density.

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SĖJOS GYLIO IR SĖKLŲ GUOLIAVIETĖS SUTANKINIMO ĮTAKA CUKRINIAMS RUNKELIAMS

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Santrauka

2004, 2005 ir 2007 m. Lietuvos žemės ūkio universiteto Bandymų stotyje dulkiško priemolio sekliai glėjiško karbonatingo išplautžemio dirvožemyje *LVg-p-w-cc(sc)-Calc(ar)i-Epihypogleyic Luvisol* atlikti tyrimai, kurių tikslas – nustatyti cukrinių runkelių sėjos gylio ir sėklų guoliavietės sutankinimo būdų įtaką cukrinių runkelių sėklų lauko daigumui, šakniavaisių derlingumui ir kokybei. Buvo tirti du veiksniai – sėjos gylis nuo seklaus iki gilaus (A veiksnys) ir sėklų guoliavietės sutankinimo būdai (B veiksnys). Sėklų guoliavietės sutankintos Kembridžo ir pentininiu volais prieš arba po sėjos.

Tyrimų duomenimis, sėjos gylio didinimas sumažino cukrinių runkelių daigumą, pasėlio tankumą, šakniavaisių derlių, pablogino jo kokybę. Cukrinių runkelių sėklų guoliavietės sutankinimas Kembridžo volu po sėjos pagerino sėklų sudygimą. Tačiau sėklų guoliavietės sutankinimo įtaka šakniavaisių derliui ir jo kokybei nebuvo iki galo nustatyta. Šių rodiklių reikšmės dažniausiai priklausė nuo sėklų sudygimo ir pasėlio tankumo susiformavimo.

Reikšminiai žodžiai: cukriniai runkeliai, sėjos gylis, sėklų guoliavietės sutankinimas, sėklų sudygimas, derlius, šakniavaisių kokybė.