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Analiza rasta tijekom vegetacije šećerne repe ovisno o gustoći sjetve

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GROWTH ANALYSIS OF SUGAR BEET IN DIFFERENT SOWING DENSITY DURING VEGETATION

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Original scientific paper
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SUMMARY

The aim of this study was to analyse sugar beet growth in field conditions during 2014 growing season. Sugar beet (hybrid Serenade, KWS) was sown on March 18th at inter–row spacing of 50 cm and four different intra–row spacings: 13 cm, 15 cm, 17 cm and 19 cm. During the growing season sugar beet plants samples were taken in eight terms from June to September. In each sampling term sugar beet leaf and root fresh weight (g/plant) were determined. Also, diameter, number and distance between cambium rings and the number of cambium rings of 1 cm diameter were determined at the cross section of the widest hypocotyl part. Sowing density had a significant effect (P≤0.05) on all observed parameters. Average fresh leaf weight for all densities of 717.84 g/plant was the highest in late July and early August. Generally, during the growing season the plants sown at wider intra–row spacings (17 and 19 cm) had on average higher root weight compared to average root weight in narrower intra–row spacings (13 and 15 cm). Average root diameter of all sowing densities increases from 4.13 cm in the first decade of June to 12.51 cm in the second decade of September wherein the diameter varied from 11.55 cm (intra–row spacing 13 cm) to 14.79 cm (intra–row spacing 19 cm). Intensive formation of cambium rings for all densities was found out in June, where at the beginning of the June, the average number of cambium rings was 4.9, while and at the end of it was 7.3. In September, sugar beet root had on average of 8.4 cambium rings. On July 30th the largest number of cambium rings at 1 cm root diameter was on the average 1.52.

Key-words: sugar beet, sowing density, weight, cambium rings, diameter

INTRODUCTION

Sugar beet (*Beta vulgaris* L. subsp. *vulgaris* var. *altissima* Döll.) is a biennial species, however, for sugar industry it is grown as one year plant, which develops a large succulent taproot and leaves through vegetative growth in the first year. At the stage of 8 to 10 leaves, root and leaf growth are quite equal, and after six weeks of age the root starts to accumulate dry matter faster than the leaves and stems (Theurer, 1979). For sugar beet sown as a spring crop leaf canopy reaches its maximum in late July and early August (Stanaćev, 1979; Theurer, 1979; Pospišil, 2013). According to Kristek and Liović (1988) and Jelić et al. (2015) in our agroecological conditions, the highest daily increase of sugar beet leaves ranges from mid–June to mid–July. Sugar beet root growth has a linear trend through the vegetation, and weather conditions have a very significant impact on the growth of the whole plant (Theurer, 1979; Pačuta et al., 2001; Hoffmann and Kluge–Severin, 2011). For example, Stanaćev (1979) reported that the greatest growth of sugar beet root ranges from mid–July to mid–August, while Jelić et al. (2015) observing sugar beet crop development in Eastern Croatia (Dalj) in 2014 (110,000 and 90,000 plants/ha) affirmed the most intense increase in fresh root weight from mid–June to mid–July. Liović and Kristek (1995) suggest that higher fresh root weight (>1000 g) results in reduced yield of sugar due to higher content of K, Na and α-amino N.

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A secondary root expansion of *Beta* species is a result of cambium rings formation. The primary cambium develops two weeks after emergence, while the first two secondary cambia were formed during the third week of plant age (Elliott and Weston, 1993). Formation of cambium rings is induced by leaves growth, where each cambium ring is connected with a certain number of leaves (Stieber and Beringer, 1984). The vascular tissues (phloem) in leaves are connected to the root in the early stages of growth and therefore it is assumed that the cambium rings formation and increment of the storage root are closely connected. Consequently, the assumption is that plants spaced wider apart develop roots of enlarged diameter and weight. Artschwager (1930) points out that the number of cambium rings is related to genes and hereditary characteristic and it varied from 8 to 11 (analysis of 13 genotypes). According to Elliott and Weston (1993) the maximum number of sugar beet root cambium rings is from 12 to 15, while Pospišil (2013) states that at the harvest time root has from 8 to 12 cambium rings. Stanaćev (1979) reported that there is a positive correlation between sugar content and the number of cambium rings. Elliott and Weston (1993) point out that about 75% of sucrose is stored in the space between 1 and 6 ring. According to Hoffmann and Kluge–Severin (2011) beet root, which has more cambium rings with smaller distance between the rings, has higher sugar content in the roots.

The aim of this study was to determine the increment of sugar beet root and canopy (g/plant) from June to September in four different intra–row spacings: 13 cm, 15 cm, 17 cm and 19 cm.

MATERIAL AND METHODS

The sugar beet vegetative growth was analysed at the Gradište location (Eastern Croatia, Vukovar Srijem County) from June to September 2014. The soil type was eutric brown soil. Sowing was performed on March 18th, 2014 (hybrid Serenade, KWS) at inter–row spacing of 50 cm and four different intra–row spacings: 13 cm, 15 cm, 17 cm and 19 cm. Samples of sugar beet plants were collected manually in the morning hours. The plants were sampled in five replicates from each density in eight sampling dates: 10th and 30th June, 10th and 30th July, 10th and 30th August, 10th and 20th September. Total of 160 individual plants were analyzed during the vegetation. Even though plant protection against fungi *Cercospora beticola* Sacc. was done four times during the vegetation, treatments had no effect, and the leaves were completely destroyed in September. Therefore, the last sampling was taken on 20th instead of 30th September.

Weight of the whole fresh root (g/plant) and fresh leaf weight (g/plant) on individual sugar beet plant samples were determined. In order to determine the impact of sowing density on the inner structure of the roots, at the cross–section of the widest part of the root (hypocotyl – about 1 cm below the scars of dried leaves) the diameter of the fresh root (cm), number and distance between the cambium rings (cm), and further number of cambium rings on 1 cm diameter were also determined. The root diameter represents mean of two perpendicular measurements at the cross–section of the root while the distance between the rings was determined in wider radius of the root cross–section.

Table 1. The weather conditions during sugar beet growing in 2014 (May to September) and the long–term mean (1981–2010) of climatological station Gradište (Meteorological and Hydrological Service, 2014)

Tablica 1. Vremenske prilike tijekom vegetacije šećerne repe 2014. godine (od svibnja do rujna) i višegodišnji prosjek (1981.–2010.) klimatološke postaje Gradište (Državni hidrometeorološki zavod, 2014.)

Month/ *Mjesec*	**Air temperature (°C)** / *Temperatura zraka (°C)*					**Rainfall (mm)** / *Oborine (mm)*				
	Vegetation 2014 / *Vegetacija 2014.*				**Mean 1981-10**	**Vegetation 2014** / *Vegetacija 2014.*				**Mean 1981-10**
	Decade / *Dekada*			Mean		**Decade** / *Dekada*			Total monthly	
	I	II	III			I	II	III		
May	14.8	14.0	21.5	**16.8**	**17.2**	60.9	101.6	2.5	**165.0**	**61.7**
June	21.3	20.1	20.9	**20.8**	**20.1**	10.9	14.9	20.4	**46.2**	**85.1**
July	22.0	21.9	24.5	**22.8**	**21.9**	16.2	40.8	26.3	**83.3**	**85.1**
August	22.5	21.7	20.7	**21.6**	**21.4**	54.0	6.1	34.1	**94.2**	**58.1**
September	18.5	17.5	14.4	**16.8**	**16.8**	52.0	20.8	23.4	**96.2**	**62.6**
Mean				***19.8***	***19.5***	***Sum***			***484.9***	***352.6***

The study was carried out with the usual agricultural practices (cultivation, protection). Generally the 2014 vegetation was wet with the total amount of 484.9 mm of rainfall, which was 132.3 mm more than in the long–term mean, while the air temperature was not much different from the long–term mean (Table 1) during the growing season.

Analysis of data through the vegetation was done by two–way ANOVA and then one–way ANOVA was used for calculation of differences for each sampling term between different intra-row spacings. The computer program "Agricultural Statistics VVStat" (2013) was used for statistical data processing and the difference between the mean values was calculated at the level of $P \leq 0.05$.

RESULTS AND DISCUSSION

The sugar beet root yield of sugar factory in Županja (Sladorana Ltd. Županja) production area was quite high, on the average 68.96 t/ha due to increased amount of rainfall during 2014 growing season. At the beginning of the vegetation the sugar beet growth was characterized by intensive canopy development in relation to the root growth. The highest increase of leaf weight by 70% was found out in June for all sowing densities, while on the other hand, the greatest decrease in the leaf weight of 30% was in August caused by *Cercospora beticola* Sacc. infection (Table 2). In general, due to increased rainfall in 2014 vegetation, plants formed rich canopies. From 10th to 30th June average increment of leaves weight amounted to 292.44 g/plant or 20.53 g/plant/day.

Kristek and Liović (1988) analysed the growth of sugar beet (variety OS Optima) through 1987 vegetation, with the lack of rainfall in the summer months, which resulted in leaves weight in the mid–June of 149 g/plant. Jelić et al. (2015) compared the fresh weight of sugar beet leaves in five different sowing densities (50,000–110,000 plants/ha) through 2014 vegetation (June – September) and reported that maximum leaves weight (1002.2 g/plant) was in August at 50,000 plants/ha, while the highest increment of leaves weight on the average for all sowing densities was determined from 17th June to 17th July (215.3 g/plant, or 6.9 g/plant/day). Kristek and Liović (1988) reported that the largest daily leaves formation was from 15th June to 15th July, and that in the second half of June leaf weight increased by 8.35 g/plant/day, while in the first half of July leaf weight increased somewhat less, by 5.11 g/plant/day.

Table 2. Fresh leaf weight (g/plant) through 2014 vegetation depending on intra–row spacing (cm)

Tablica 2. Masa svježega lista (g/biljci) kroz vegetaciju 2014. godine, ovisno o razmaku sjetve unutar reda (cm)

Date / *Datum* **(B)**	**Intra–row spacing (cm)** / *Razmak (cm) unutar reda* ***(A)***				**Average** / *Prosjek* **(B)**	*LSD (A) 0.05*
	13	15	17	19		
	Fresh leaf weight (g/plant) / *Masa svježega lista (g/biljci) šećerne repe*					
10th June	139.70	125.32	103.51	104.22	**118.19** ^{e}	*Ns*
30th June	291.81 ^{b}	491.72 ^{a}	410.25 ^{a}	448.74 ^{a}	**410.63** ^{cd}	*110.01*
10th July	385.94	527.84	523.42	514.78	**488.00** ^{bc}	*Ns*
30th July	495.86	668.20	748.18	828.10	**685.09** ^{a}	*Ns*
10th August	539.57	659.18	809.92	862.70	**717.84** ^{a}	*Ns*
30th August	325.21 ^{c}	452.41 ^{bc}	723.21 ^{a}	590.97 ^{ab}	**522.95** ^{b}	*222.34*
10th September	306.93	339.83	383.24	391.03	**355.26** ^{d}	*Ns*
20th September	216.99	148.51	183.87	224.86	**193.56** ^{e}	*Ns*
Average / *Prosjek* **(A)**	**337.75** ^{c}	**426.63** ^{b}	**485.70** ^{a}	**495.68** ^{a}	**436.44**	*58.38*
				LSD (B) 0.05	*79.81*	

Differences in the mean values of the same letters **abc** compared to columns of factor (**A**) and rows of factor (**B**) are not statistically significant at the level P≤0.05 / *Razlike srednjih vrijednosti iste slovne oznake* ***abc*** *u usporedbi po kolonama za faktor (A) i u usporedbi po redovima za faktor (B) nisu statistički značajne na razini P≤0,05*

In this study, on the last sampling date (September 20th), the fresh leaf weight significantly decreased due to infection with *Cercospora beticola* Sacc. In favourable weather conditions, especially rainfall in 2014, beet started to form young leaves of smaller sizes. Kristek et al. (2013) reported that even with regular use of fungicides, *Cercospora beticola* Sacc. in our agro ecological conditions occur every year, especially in wetter years. Jelić et al. (2015) reported that considering higher amount of rainfall in 2014 Cercospora completely destroyed leaves and at 90,000 plants/ha, sugar beet leaf and root weight ratio was largest in September, amounting 1:7.95, with average root weight of 1475.0 g/plant.

On the average for all densities the largest increment of sugar beet root weight for 455.62 g/plant, or 22.8 g/plant/day was from 10th to 30th July, while considering the different densities, the increase of root weight was significantly different only from the end of July (Table 3). In the same year (2014) Jelić et al. (2015) found out the greatest increment in root weight from mid–June to mid–July (average 891.5 g/plant or 23.0 g/plant/day), while after July root growth gradually slowed. Kristek and Liović (1988) in 1987, which was a year with accentuated lack of rainfall in the summer months, determined that the maximum increment of sugar beet root by 5.9 g/plant/day, at the end of growing season, in September. In the individual analysis of the 4445 sugar beet roots in harvest (110,000 plants/ha), Liović and Kristek (1995) reported that the roots with weight around 400 g (31.1%) had the greater share, than the roots of about 600 g (26.0%) and the roots of about 800 g (17.1%), while roots weighing from 1000 to 1500 kg were present in less than 10.0%. Furthermore, the authors state that the roots of about 800 g had the highest sugar content of 15.66%, and that sugar beet with lager root weight resulted in sugar content decrease. By comparing different numbers of sugar beet plants per unit area in very wet growing season, Jelić et al. (2015) reported that at 30,000 and 50,000 plants/ha sugar beet root weight in mid–September was on the average 2227 g/plant, while at 70,000, 90,000 and 110,000 plants/ha average root weight was 1569 g/plant.

Table 3. Fresh root weight (g/plant) through 2014 vegetation depending on intra–row spacing (cm)

Tablica 3. Masa svježega korijena (g/biljci) kroz vegetaciju 2014. godine, ovisno o razmaku sjetve unutar reda (cm)

Date / *Datum* **(B)**	**Intra–row spacing (cm)** / *Razmak (cm) unutar reda* ***(A)***				**Average** *Prosjek* **(B)**	*LSD (A) 0.05*
	13	15	17	19		
	Fresh root weight (g/plant) *Masa svježega korijena (g/biljci) šećerne repe*					
10th June	82.76	65.55	51.68	79.09	**69.77** ^{e}	*Ns*
30th June	234.79	358.86	348.16	421.03	**340.71** ^{d}	*Ns*
10th July	482.19	448.53	663.31	888.94	**620.74** ^{c}	*Ns*
30th July	703.20 ^{c}	1063.10 ^{b}	960.78 ^{b}	1578.38 ^{a}	**1076.36** ^{b}	*338.50*
10th August	853.63 ^{bc}	1047.62 ^{b}	1405.88 ^{ab}	1650.50 ^{a}	**1239.41** ^{b}	*514.25*
30th August	1025.66 ^{b}	1440.68 ^{b}	1602.34 ^{ab}	2376.02 ^{a}	**1611.18** ^{a}	*733.67*
10th September	919.87 ^{bc}	1361.48 ^{b}	1478.88 ^{b}	2752.68 ^{a}	**1628.23** ^{a}	*505.89*
20th September	1417.97 ^{b}	1602.62 ^{b}	1233.21 ^{b}	3047.56 ^{a}	**1825.34** ^{a}	*797.41*
Average / *Prosjek* **(A)**	**715.01** ^{c}	**923.56** ^{bc}	**968.03** ^{b}	**1599.27** ^{a}	**1021.47**	*224.95*
				LSD (B) 0.05	*229.19*	

Differences in the mean values of the same letters **abc** compared to columns of factor (**A**) and rows of factor (**B**) are not statistically significant at the level P≤0.05 / *Razlike srednjih vrijednosti iste slovne oznake* ***abc*** *u usporedbi po kolonama za faktor (A) i u usporedbi po redovima za faktor (B) nisu statistički značajne na razini P≤0,05*

Sugar beet root diameter was gradually increased with maturation and as expected differed depending on the sowing density (Table 4). The largest increase in the root diameter was from 10th to 30th June, and it ranged from 1.32 cm to the plants at a distance of 13 cm to an average of 3.42 cm in the plants at a distance of 17 and 19 cm. Significant horizontal root increment was on the average found out from 10th to 30th July (2.26 cm), while from 10th August to 20th September horizontal root increment was 0.03 cm/day. In the last sampling term (September 20th) the difference in the root diameter was expressed only in the widest sowing spacing plants, whose average diameter was 14.79 cm, while for the other plant densities root diameter was on the average 11.75 cm.

Enlargement of the root diameter was followed by enlargement of the cambium rings number, which differed significantly depending on the sowing density only in June and at the end of the growing season there were no statistically significant differences in the cambium rings number reference to sowing density (Table 5). In this study, on 20th September, sugar beet root had 8.4 cambium rings. Hoffmann (2010) reported that most of cambium rings in sugar beet root began to form 10 weeks after sowing and that on the average two more cambial rings were formed by the end of vegetation. Elliott and Weston (1993) suggested that the formation of the cambial rings intense six weeks after emergence of sugar beet, and when the plant has 12–13 leaves, root diameter varied from 1 to 1.5 cm with six cambium rings.

Table 4. Fresh root diameter (cm) through 2014 vegetation depending on intra–row spacing (cm)

Tablica 4. Promjer svježega korijena (cm) šećerne repe kroz vegetaciju 2014. godine, ovisno o razmaku sjetve unutar reda (cm)

Date / *Datum* **(B)**	**Intra–row spacing (cm)** / *Razmak (cm) unutar reda* ***(A)***				**Average** / *Prosjek* **(B)**	*LSD (A) 0.05*
	13	15	17	19		
	Sugar beet fresh root diameter (cm) / *Promjer svježega korijena (cm) šećerne repe*					
10th June	4.38	3.88	3.86	4.38	**4.13** ^{e}	*Ns*
30th June	5.70 ^{b}	7.22 ^{a}	7.28 ^{a}	7.80 ^{a}	**7.00** ^{d}	*1.03*
10th July	7.82	7.60	8.56	9.66	**8.41** ^{c}	*Ns*
30th July	9.20 ^{b}	10.66 ^{b}	10.46 ^{b}	12.36 ^{a}	**10.67** ^{bc}	*1.54*
10th August	9.78 ^{c}	10.10 ^{bc}	11.52 ^{ab}	12.42 ^{a}	**10.96** ^{b}	*1.53*
30th August	10.16	10.72	11.48	13.54	**11.48** ^{ab}	*Ns*
10th September	10.00 ^{c}	11.56 ^{b}	12.24 ^{b}	13.84 ^{a}	**11.91** ^{a}	*1.06*
20th September	11.55 ^{b}	11.85 ^{b}	11.84 ^{b}	14.79 ^{a}	**12.51** ^{a}	*1.92*
Average / *Prosjek* **(A)**	**8.58** ^{c}	**9.20** ^{bc}	**9.66** ^{b}	**11.09** ^{a}	**9.63**	*0.71*
				LSD (B) 0.05	*0.75*	

Differences in the mean values of the same letters **abc** compared to columns of factor (**A**) and rows of factor (**B**) are not statistically significant at the level P≤0.05 / *Razlike srednjih vrijednosti iste slovne oznake* ***abc*** *u usporedbi po kolonama za faktor (A) i u usporedbi po redovima za faktor (B) nisu statistički značajne na razini P≤0,05*

Table 5. Number of cambium rings of fresh root through 2014 vegetation depending on intra–row spacing (cm)

Tablica 5. Broj kambijalnih prstenova svježeg korijena kroz vegetaciju 2014. godine, ovisno o razmaku sjetve unutar reda (cm)

Date / *Datum* **(B)**	**Intra–row spacing (cm)** / *Razmak (cm) unutar reda* ***(A)***				**Average** / *Prosjek* **(B)**	*LSD (A) 0.05*
	13	15	17	19		
	Number of cambium rings of fresh root / *Broj kambijalnih prstenova svježega korijena šećerne repe*					
10th June	5.6 a	5.2 a	4.2 b	4.4 ab	**4.9 e**	*0.91*
30th June	6.6 b	7.4 a	7.0 ab	7.6 a	**7.2 cd**	*0.67*
10th July	7.0	7.0	7.4	7.2	**7.2 cd**	*Ns*
30th July	7.0	7.2	6.8	7.2	**7.1 d**	*Ns*
10th August	7.8	7.4	7.8	8.0	**7.8 b**	*Ns*
30th August	8.6	9.0	8.4	8.2	**8.6 a**	*Ns*
10th September	8.0	8.0	9.0	8.4	**8.4 a**	*Ns*
20th September	8.8	8.6	8.0	8.2	**8.4 a**	*Ns*
Average / *Prosjek* **(A)**	**7.4**	**7.5**	**7.3**	**7.4**	**7.4**	*Ns*
				LSD (B) 0.05	*0.36*	

Differences in the mean values of the same letters **abc** compared to columns of factor (**A**) and rows of factor (**B**) are not statistically significant at the level P≤0.05 / *Razlike srednjih vrijednosti iste slovne oznake* ***abc*** *u usporedbi po kolonama za faktor (A) i u usporedbi po redovima za faktor (B) nisu statistički značajne na razini P≤0,05*

Gemtos et al. (2000) reported that the sugar beet root diameter at the ground level is very significantly influenced (P=0.01) by the amount of water in the soil, soil compaction and soil type, and that the diameter of root, 30 days after sowing, varied from 1.71 to 4.15 mm. Root thickening and dry matter accumulation was studied in other related species of Chenopodiaceae. In the analysis of growth through the vegetation (March – September), at intervals of one week, Stagnaro et al. (2014) reported that at the water capacity of 100%, the maximum increase in red beet root dry matter was 40 to 47 days after germination (>5 g/plant) and that higher increment of root diameter was on 33 to 40 days after germination (>2 cm/plant). After that period horizontal increment of the red beet roots slowed down. Hoffmann (2010) reported that fodder beet has most commonly 6 cambium rings, whereas in comparison with fodder beet and sugar beet 12 weeks after sowing, the difference in the distance between the rings of fodder and sugar beet was less accentuate, while 28 weeks after sowing the largest difference was in range between the core and the first ring.

The largest number of cambium rings on 1 cm diameter of fresh root diameter was on 30th July on the average 1.52 (Table 6). Artschwager (1930) reported that typical ratio in radius of mature sugar beets between mature and younger cambium rings was 10:1. Stanaćev (1979) states that there is positive correlation between sugar content and the number of cambium rings in sugar beet, and gives an example that Z types have 3.2, while E types have 2.9 ring on 1 cm of root diameter.

Table 6. Number of cambium rings on 1 cm diameter of fresh root diameter (cm) through 2014 vegetation depending on intra–row spacing (cm)

Tablica 6. Broj kambijalnih prstenova na 1 cm promjera svježega korijena u najširem dijelu korijena šećerne repe kroz vegetaciju 2014. godine, ovisno o razmaku sjetve unutar reda (cm)

Date / *Datum* **(B)**	**Intra–row spacing (cm)** / *Razmak (cm) unutar reda* ***(A)***				**Average** / *Prosjek* **(B)**	*LSD (A) 0.05*
	13	15	17	19		
	Number of cambium rings on 1 cm diameter of fresh root diameter / *Broj kambijalnih prstenova na 1cm promjera svježega korijena šećerne repe*					
10th June	0.78 b	0.74 b	0.93 ab	0.99 a	**0.86 e**	*0.20*
30th June	0.86 b	0.97 ab	1.04 a	1.02 a	**0.97 d**	*0.11*
10th July	1.13 a	1.08 b	1.16 ab	1.33 a	**1.17 c**	*0.23*
30th July	1.31	1.50	1.54	1.72	**1.52 a**	*Ns*
10th August	1.26 b	1.37 b	1.49 a	1.55 a	**1.42 ab**	*0.21*
30th August	1.18 b	1.18 b	1.37 a	1.66 a	**1.35 b**	*0.27*
10th September	1.26 b	1.44 b	1.36 b	1.65 a	**1.43 ab**	*0.19*
20th September	1.30 b	1.39 b	1.48 b	1.80 a	**1.49 ab**	*0.22*
Average / *Prosjek* **(A)**	**1.13 c**	**1.21 b**	**1.30 b**	**1.47 a**	**1.28**	*0.10*
				LSD (B) 0.05	*0.10*	

Differences in the mean values of the same letters **abc** compared to columns of factor (**A**) and rows of factor (**B**) are not statistically significant at the level P≤0.05 / *Razlike srednjih vrijednosti iste slovne oznake* ***abc*** *u usporedbi po kolonama za faktor (A) i u usporedbi po redovima za faktor (B) nisu statistički značajne na razini P≤0,05*

In this study the distance between cambium rings was different depending on the sowing density and plant age (Figure 1). The widest distance on the average for all densities and sampling terms was found out between the second and seventh ring, average 0.4 cm, while towards the periphery, from 7 to 10 ring the distance was smaller, on the average 0.1 cm. Hoffman (2010) also states that in the sugar beet root the greater distance was between the inner ring (4 to 6) in relation to the distance between the ring toward the periphery (from 6 to 10 ring).

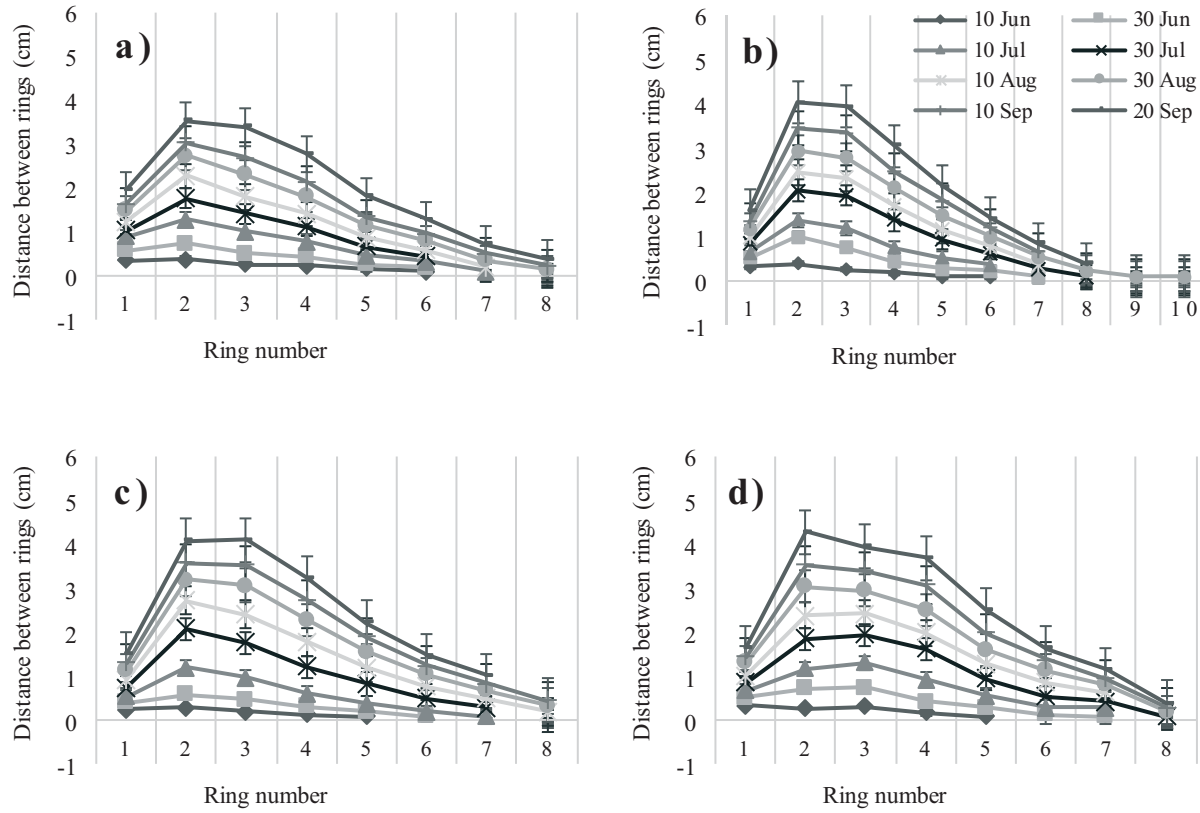

Figure 1. The distance between cambium rings (inner – outer) in eight harvest date through the vegetation at different intra–row spacing: a) 13 cm, b) 15 cm, c) 17 cm d) 19 cm. Error bars indicate significant differences at each harvest date at P<0.05

Grafikon 1. Razmak između kambijalnih prstenova (unutrašnji – vanjski) u osam rokova kroz vegetaciju ovisno o razmaku u redu: a) 13 cm, b) 15 cm, c) 17 cm i d) 19 cm. Stupci ukazuju na značajne razlike ovisno o datumu uzorkovanja na razini P<0,05

CONCLUSION

Generally, sowing denstiy had a significant impact on the weight of fresh leaves and roots, and on the inner structure of root through the vegetation. The highest average increase of leaf weight by 70% was found out in June for all densities. From 10th to 30th July the greatest increase of root weight was on the average 455.62 g/plant. The largest increase in root diameter for all densities was found out in June and at the end of the first decade of June, root diameter was 4.13 cm, whereas it increased up to 7.00 cm at the end of June. Intensive formation of cambium rings was also established in June, and the average for all sowing density was from 4.9 to 7.3, while by the September roots had an average of 8.4 cambium ring. The distance between cambium rings also increased with sugar beet maturation in different intensity as depended of sowing density, with the largest distance between the inner rings (from 2 to 5 rings).

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ANALIZA RASTA TIJEKOM VEGETACIJE ŠEĆERNE REPE OVISNO O GUSTOĆI SJETVE

SAŽETAK

U ovom istraživanju praćen je rast šećerne repe u poljskim uvjetima uzgoja tijekom vegetacije šećerne repe u 2014. godini na lokaciji Gradište (Vukovarsko–srijemska županija). Sjetva šećerne repe (hibrid Serenada, KWS) obavljena je 18. ožujka 2014. na međuredni razmak od 50 cm i četiri različita razmaka unutar reda: 13 cm, 15 cm, 17 cm i 19 cm. Tijekom vegetacije u osam rokova od lipnja do rujna uzimani su uzorci biljaka na kojima je utvrđena masa svježega lista i korijena (g/biljci), a u poprečnome presjeku najširega dijela vrata korijena (hypocotyl) određen je promjer, broj i razmak između kambijalnih prstenova te broj kambijalnih prstenova na 1 cm promjera. Gustoća sjetve imala je značajan utjecaj ($P \leq 0,05$) na sve analizirane parametre. Prosječno je za sve gustoće sjetve masa svježega lista od 717,84 g/biljci bila najveća krajem srpnja i početkom kolovoza. Općenito su biljke sijane na širi razmak u redu (17 i 19 cm) kroz cijelu vegetaciju imale prosječno veću masu korijena u odnosu na prosječnu masu korijena užega razmaka sjetve unutar reda (13 i 15 cm). Promjer korijena prosječno za sve gustoće sjetve iznosio je 4,13 cm na kraju prve dekade lipnja, do 12,51 cm u drugoj dekadi rujna, pri čemu je promjer varirao od 11,55 cm, u najgušćoj sjetvi, do 14,79, u najrjeđoj sjetvi. Nadalje, prosječno za sve gustoće sjetve intenzivno stvaranje kambijalnih prstenova utvrđeno je u lipnju te je početkom lipnja broj prstenova iznosio prosječno 4,9, a na kraju lipnja prosječno 7,3. U rujnu je korijen šećerne repe imao prosječno 8,4 kambijalna prstena, dok je na 1 cm promjera korijena najveći broj prstenova od prosječno 1,52 utvrđen 30. srpnja.

Ključne riječi: šećerna repa, gustoća sjetve, masa, kambijalni prstenovi, promjer

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