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EFFECT OF SOIL MANAGEMENT SYSTEMS ON THE VEGETATIVE GROWTH POTENTIAL OF BLACK CURRANT (*RIBES NIGRUM* L.) CULTIVARS

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Summary: *This experiment evaluated the effect of soil management systems on the vegetative growth potential of black currant (Ribes nigrum L.) cultivars. Three soil management systems were used: I – bare fallow i.e. continuous tillage; II – sawdust mulch, and III – black polyethylene foil mulch. Six black currant cultivars were included: 'Ben Lomond', 'Ben Sarek', 'Titania', 'Čačanska Crna', 'Tisel' and 'Tiben'. The highest values of vegetative growth parameters were obtained in 'Čačanska Crna' and 'Ben Lomond' and the lowest in 'Ben Sarek'. Bare fallow and sawdust mulch treatments showed no differences in the tested parameters, whereas significantly lower values were recorded under foil mulch treatment.*

Key words: *black currant (Ribes nigrum L.), bare fallow, sawdust, foil, vegetative growth potential.*

INTRODUCTION

Bush size in black currant (Ribes nigrum L.) cultivars is an important morphological characteristic that governs the efficiency of mechanised harvest and the degree of shoot damage by the harvester (Pluta and Zurawicz, 2008). Vegetative growth potential is a variable trait affected not only by the genetic background, but also by cultural and pruning practices during currant cultivation. The number and length of one-year-old shoots and bush size have a large indirect effect on yield per plant (Madry et al., 2000). Under the agroenvironmental conditions in Serbia, black currant is mostly grown under bare fallow treatment. More recently, mulching with sawdust or foil has been increasingly used. While some authors have reported a positive effect of sawdust mulch in black currant orchards on the vegetative growth of the bush, others have found that foil mulch contributes to increasing shoot number and shoot length i.e. improving overall bush growth (Robinson, 1991; Larsson, 1997; Kivijarvi et al., 2005; Dill, 2008).

The objective of this study was to examine the effect of soil management systems on the vegetative growth potential of black currant (*Ribes nigrum* L.) cultivars.

MATERIAL AND METHOD

The research was conducted at the Fruit Research Institute, Čačak, during 2012-2014. The black currant orchard was established in the spring of 2011 using two-year-old plants. Black currants were grown as bushes at a spacing of 3 m between rows and 1 m in the row. Six cultivars were used: 'Ben Lomond', 'Ben Sarek', 'Čačanska Crna', 'Titania', 'Tiben' and 'Tisel'. Three soil management systems were employed: treatment I – bare fallow i.e. continuous tillage, treatment II – sawdust mulch, and treatment III – black polyethylene foil mulch. The experiment was laid out in a randomised block design with six cultivars, three replications and three soil management systems, giving a total of 270 black currant bushes.

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The following parameters of the vegetative growth potential of the studied black currant cultivars were evaluated: 1. number of shoots per bush; 2. shoot length; 3. length of newly developed shoots; 4. bush height; 5. bush width and 6. bush volume. These vegetative growth parameters were counted or measured using a metre at the end of the growing season. They are expressed in cm. Bush volume was calculated using the truncated cone formula, and is expressed in m^3.

The experimental data obtained during the three-year research period were subjected to statistical analysis using Fisher's three-factor analysis of variance - ANOVA. The significance of differences between the mean values of the tested factors and the interaction means was determined by LSD test at $P \leq 0.01$ and $P \leq 0.05$ significance levels. The results are presented in tabular form.

RESULTS

The analysis of variance (F-test) showed highly significant differences in vegetative growth potential between cultivars, treatments and years. Cultivar x treatment x year interactions were observed in bush volume, but not in the other tested parameters. The results on the vegetative growth potential of the black currant cultivars are presented in Tables 1a and 1b.

Table 1a. Vegetative growth potential

Cultivar/Treatment/Year		Number of shoots per bush	Shoot length (cm)	Length of newly developed shoots (cm)
Cultivar (A)	'Ben Lomond'	6.17±0.45 a	107.6±2.78 b	85.6±2.76 a
	'Ben Sarek'	4.48±0.44 b	69.7±2.99 e	52.6±2.69 d
	'Titania'	4.84±0.46 b	94.0±3.42 d	73.9±3.41 c
	'Čačanska Crna'	2.17±0.24 c	111.6±3.07 a	85.9±2.95 a
	'Tisel'	6.01±0.53 a	104.3±2.52 c	78.6±3.12 b
	'Tiben'	5.86±0.57 a	104.8±4.48 c	85.4±3.65 a
Treatment (B)	bare fallow	4.96±0.35 b	102.3±3.11 a	81.2±2.67 a
	sawdust	5.48±0.38 a	100.4±3.14 a	80.4±2.95 a
	foil	4.33±0.37 c	93.3±2.55 b	69.3±2.15 b
Year (C)	2012	7.73±0.33 a	79.5±2.03 c	61.4±1.59 c
	2013	4.33±0.19 b	102.2±2.35 b	77.1±2.39 b
	2014	2.70±0.17 c	114.3±2.34 a	92.5±2.18 a
ANOVA				
Cultivar (A)		**	**	**
Treatment (B)		**	**	**
Year (C)		**	**	**
A x B		*	*	*
A x C		**	**	**
B x C		**	**	**
A x B x C		ns	ns	ns

- Means followed by different letters within the cultivar, treatment and year columns are significantly different at $P \leq 0.01$ and $P \leq 0.05$ according to LSD test and ANOVA (F-test) results.

During the three-year research period, the number of shoots per bush was highest in 'Ben Lomond' (6.17), 'Tisel' (6.01) and 'Tiben' (5.86), and the lowest in 'Čačanska Crna' (2.17). The highest value for average shoot length was obtained in 'Čačanska Crna' (111.6 cm) and the length of newly developed shoots was greatest in 'Čačanska Crna' (85.9 cm), 'Ben Lomond' (85.6 cm) and 'Tiben' (85.4 cm), whereas the lowest values for shoot length (69.7 cm) and newly developed shoots (52.6 cm) were recorded in 'Ben Sarek'.

Bush vigour of black currants is determined by bush height and bush width. Bush vigour largely affects the number of plants per unit area, the use of mechanised harvest and production success.

On average, bush height was largest in 'Čačanska Crna' (124.8 cm) and bush width in 'Ben Lomond' (155.3 cm) and 'Čačanska Crna' (154.0 cm), whereas the lowest values were recorded in 'Ben Sarek' (bush height - 78.1 cm; bush width - 91.7 cm).

Bush volume is defined as the degree of vigour of black currant i.e. the vegetative growth potential of the cultivar. The highest average values of bush volume were obtained in 'Čačanska Crna' (1.54 m^3) and 'Ben Lomond' (1.53 m^3), and the lowest in 'Ben Sarek' (0.44 m^3).

Based on the international descriptor for black currant (UPOV, 2009), the studied black currant cultivars are classified into two groups according to bush volume: 1. moderately vigorous cultivars (bush volume 0.3 - 0.5 m^3): 'Ben Sarek' and 2. very vigorous cultivars (bush volume > 0.7 m^3): 'Ben Lomond', 'Titania', 'Čačanska Crna', 'Tisel', 'Tiben'.

As for treatments, the number of shoots per bush was highest under sawdust mulch and lowest under foil mulch treatment. Bare fallow and sawdust mulch treatments did not differ in the other tested parameters of vegetative growth potential, whereas significantly lower values were obtained under foil mulch treatment.

Years showed highly significant differences in the number of shoots per bush, with the highest numbers obtained in 2012 and the lowest in 2014. The other vegetative growth parameters showed the highest values in 2014 and the lowest in 2012.

Table 1b. Vegetative growth potential

Cultivar/Treatment/Year		Bush height (cm)	Bush width (cm)	Bush volume (m^3)
Cultivar (A)	'Ben Lomond'	119.6±3.13 b	155.3±5.84 a	1.53±0.19 a
	'Ben Sarek'	78.1±2.89 e	91.7±4.62 d	0.44±0.05 d
	'Titania'	103.2±3.32 d	109.7±5.93 c	0.76±0.10 c
	'Čačanska Crna'	124.8±3.52 a	154.0±5.36 a	1.54±0.18 a
	'Tisel'	113.8±2.33 c	133.1±3.77 b	0.91±0.09 b
	'Tiben'	121.0±5.27 ab	127.6±4.08 b	0.85±0.10 bc
Treatment (B)	bare fallow	114.5±3.47 a	133.5±4.69 a	1.14±0.12 a
	sawdust	111.9±3.33 a	135.0±5.19 a	1.15±0.12 a
	foil	103.8±2.88 b	117.2±3.66 b	0.72±0.05 b
Year (C)	2012	91.4±2.19 c	103.1±3.35 c	0.45±0.02 c
	2013	112.5±2.77 b	129.9±3.95 b	0.92±0.06 b
	2014	126.4±2.90 a	152.6±4.02 a	1.65±0.12 a
ANOVA				
Cultivar (A)		**	**	**
Treatment (B)		**	**	**
Year (C)		**	**	**
A x B		*	**	**
A x C		**	*	**
B x C		**	**	**
A x B x C		ns	ns	**

- Means followed by different letters within the cultivar, treatment and year columns are significantly different at P≤0.01 and P≤0.05 according to LSD test and ANOVA (F-test) results

DISCUSSION

The analysis of the present results reveals that they are partially comparable with the findings of Georgiev et al. (2008) in terms of bush height (110-140.3 cm), but not in terms of bush width (96.7-139 cm). Bush height and bush width in the present study were greater in 'Ben Lomond', 'Tiben' and 'Tisel', whereas 'Titania' had greater bush height and almost identical bush width relative to the values reported by Sasnauskas et al. (2008). In their analysis of the vegetative growth potential of 80 black currant genotypes, Kampuss and Strautina (2004) determined greater bush height in 'Titania' than in this experiment, whereas Rolbiecki et al. (2002) reported significantly lower bush height in the same cultivar. The present experimental results on bush volume are significantly lower than in Pluta and Zurawicz (2008) and Pluta et al. (2008), whereas Đorđević (2012) obtained similar values for bush height, but not for bush width. According to bush volume, Đorđević (2012) classified the studied black currant cultivars into low vigour ('Ben Sarek'), medium vigour ('Titania') and vigorous cultivars ('Ben Lomond', 'Čačanska Crna'), which is not comparable with the classification in this experiment. The present results are not in agreement with Rolbiecki et al. (2002), Vater and Arena (2002), Sasnauskas et al. (2012) and Madry et al. (2010) in terms of the number and length of one-year-old shoots in 'Ben Lomond' and 'Titania', but they are within the range of values reported by Đorđević (2012).

The number of shoots per bush was highest in sawdust mulch treatment, whereas no differences in the other parameters were found between bare fallow and sawdust mulch treatments. It is assumed that sawdust mulch had a favourable effect on the number of shoots due to lower variations in soil temperature during the day and reduced soil evaporation when compared to foil mulch treatment. Sawdust as a substrate promotes rooting, which is a potential factor in increasing the number of shoots per bush in the tested cultivars. Foil did not have a positive effect on the studied parameters of vegetative growth potential. Poorer performance under foil mulch treatment is due to elevated soil temperature and humidity under the foil throughout the growing season, and particularly during the summer, as compared to sawdust and bare fallow.

Kivijarvi et al. (2005) found that foil mulching contributes to increasing bush volume. In 'Ben Lomond' grown on foil, Dill (2008) also obtained greater bush height than in cultivars produced without foil, but the differences were not significant. The results of this study are not comparable with the findings of the abovementioned authors. Sawdust mulching produces better results than foil since sawdust directly increases bush growth by 30-40% (Robinson, 1991). The conclusions on the use of sawdust mulch are applicable to the results of this experiment. In Sweden, Larsson (1997) found that foil or sawdust mulching is effective in increasing shoot and bush growth. Both two- and one-year-old shoots exhibited the highest growth on foil, followed by sawdust and bare fallow. However, prolonged use of sawdust and foil is less effective in increasing bush growth than the use of bare fallow. Pedersen (2002) also reported intense bush growth in 'Tiben' and 'Titania' under different types of mulches. The results achieved by these authors in Western and Northern European countries are in direct disagreement with those reported in this experiment.

The highest number of shoots per bush was obtained in 2012 and the lowest in 2014. Being a shrub-type fruit species, the currant yields a large number of shoots in the second year after planting, whereas in later years their number decreases. This is one of the reasons for the higher shoot production in 2012. Moreover, sawdust as a substrate promotes rooting as a factor that contributes to increasing the number of shoots per bush. The other parameters of vegetative growth potential were highest in 2014, and lowest in 2012. The resulting differences in vegetative growth potential are justifiable, given the difference in bush age in the black currant orchard during the three-year research period.

CONCLUSION

The tested cultivars are suitable for growing under the agroenvironmental conditions in Čačak, given their good vegetative growth potential.

Knowledge of vegetative growth potential is very important in terms of orchard establishment since cultivars having a great bush volume require a high within-row plant spacing.

'Ben Sarek' is recommended for high density planting system due to its lower bush volume when compared to the other studied cultivars which require a wider plant spacing.

The tested cultivars had a greater bush width than height, thus forming a horizontally spreading shrub.

Bare fallow and sawdust mulches are more suitable for the commercial cultivation of the tested black currant cultivars compared to polyethylene foil which is a less effective soil management method as regards vegetative growth potential.

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UTICAJ NAČINA ODRŽAVANJA ZEMLJIŠTA NA VEGETATIVNI POTENCIJAL SORTI CRNE RIBIZLE (*RIBES NIGRUM* L.)

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Izvod: U eksperimentu je praćen uticaj načina održavanja zemljišta na vegetativni potencijal sorti crne ribizle (*Ribes nigrum* L.). Primenjena su tri načina održavanja zemljišta: 1. - održavanje zemljišta u vidu jalovog ugara; 2. - održavanje zemljišta zastiranjem strugotinom i 3. - održavanje zemljišta zastiranjem folijom. Ogledom je obuhvaćeno šest sorti crne ribizle: Ben lomond, Ben sarek, Čačanska crna, Titanija, Tiben i Tisel. Najveće vrednosti ispitivanih parametara vegetativnog potencijala zabeležene su kod sorti 'Čačanska Crna' i 'Ben Lomond', a najmanje kod sorte 'Ben Sarek'. Tretmani sa jalovim ugarom i strugotinom nisu se se razlikovale u ispitivanim parametarima, dok su značajno manje vrednosti registrovane u tretmanu sa folijom.

Ključne reči: *crna ribizla (Ribes nigrum* L.*), jalovi ugar, strugotina, folija, vegetativni potencijal*

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