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THE IMPACT OF CUTTING AND MULCHING GRAPEVINE REGENT ON YIELDING AND FRUIT QUALITY

WPŁYW CIĘCIA I MULCZOWANIA NA PLONOWANIE I JAKOŚĆ OWOCÓW WINOROŚLI ODMIANY REGENT

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Streszczenie: Badania przeprowadzono w latach 2010–2011, w Pracowni Sadownictwa Zachodniopomorskiego Uniwersytetu Technologicznego w Szczecinie. Określono wpływ mulczowania gleby oraz liczby latorośli na łozie na jakość i wielkość plonu winorośli odmiany Regent. Krzewy posadzono w glebie gliniastej, III klasy bonitacyjnej, zasobnej w składniki mineralne. Ściółkowanie gleby okazało się niekorzystne ze względu na pogorszenie jakości owoców. Winogrona zawierały mniej ekstraktu (14,1%), więcej kwasów organicznych (0,90 g) i azotanów (83 mg) oraz niższym odczynem soku (3,25) w porównaniu z roślinami nie ściółkowanymi. Cięcie łozy na sześć oczek wpłynęło na uzyskiwanie większych gron, dłuższych (16,4 cm) i o większej masie (208 g) w porównaniu do gron zebranych z roślin prowadzonych na dziesięć pędów. Prowadzenie krzewów na krótsze łozy powodowało lepsze doświetlenie roślin, co wpłynęło na zwiększenie zawartości ekstraktu w owocach (15,8%) i obniżenie zawartości azotanów (71 mg). Owoce były również jędrniejsze (186 G), ciemniejsze (parametr L* 23,54) i o większej zawartości substancji odpowiedzialnych za barwę niebieską (parametr b* –12,19), wymagały natomiast większej siły do oderwania owocu od szypułki (119 G).

Key words: chemical composition, cultivation, fruits color, *Vitis,* yield.
Słowa kluczowe: barwa owoców, plon, skład chemiczny, uprawa, *Vitis*.

INTRODUCTION

The quality of fruits and, as a result, the quality of wine is determined by a large number of factors, starting from the topography, soil, climate and even the microclimate in a given region of cultivation and ending with the competences of the winemaker, who is capable of selecting appropriate varieties and the appropriate technology for cultivation and processing of the raw material (Casamayor 2008). The acidity, the extract, the type of aroma, the ability of the wine to age depend largely on local conditions (Bosak 2004). In Poland, grapevines are cultivated nearly all over the country, however, the leading regions include Subcarpathian, Lubuskie, Lower Silesia and Lesser Poland Provinces (Bieńczyk and Bońkowski 2008).

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Wine growing in the West Pomeranian Province started in the 13th century. Vineyards were situated around the Pomeranian dukes' castle in Szczecin, Schwerin, Gustrow and Stargard (Chełpiński et al. 2009). The majority of the West Pomeranian Province and Mecklenburg-Western Pomerania belong to the same zone of plant frost resistance. This is zone 7A on the Heinz and Schreiber's "Map of zones of plant resistance to frost". Minimal temperatures range from –15ºC to –17ºC here. However, in the area of Szczecin and in the nearby northern region, minimal temperatures range from –12ºC to –15ºC, which corresponds to values typical of zone 7B. Plants which are not found in any other Polish regions can be encountered in Szczecin and its vicinity. Before World War II, grapevine were cultivated in Połczyn-Zdrój and in Szczecin (Chełpiński 2009), which is confirmed by old photographs showing vineyards on the hill that used to be called Wzgórze Winne (Wine Hill, Weinberg in German).

Cutting is an important and necessary component of grapevine care, used to achieve high yields and fruits of optimal size with a proper colour and with optimal extract content. To prevent burdening grapevines with too many fruits and to prevent reduction in the quality of fruits, the number of shoots left needs to be regulated (Myśliwiec 2006). In the Polish climate, due to the threat of insufficient temperatures and insulation which may prevent the achievement of high quality fruit, this treatment plays a significant role (Lisek 2011).

The selection of the optimal form of shaping the vine and its load, i.e. the number of buds left and the appropriate density of planting guarantees optimal yields. In Poland, no more than 10 tonnes of grapes should be harvested from 1 hectare of a vineyard to obtain high quality material. Similar quantities of grapes are collected in some wine-making countries in the European Union (Lisek 2007a). The optimal load for one shoot is 120–140 g fruits, which usually corresponds to the weight of one cluster (Senator 2007). Mulching should not be forgotten either, as this is one of the most important agrotechnical treatments determining the quality of the fruit (Maskalaniec 1995, Kasperbauer 2000). This activity inhibits weed development, increases the effectiveness of watering and influences the soil temperature (Neuweiller 1997). Organic (bark, sawdust, straw, peat) or synthetic materials can be used for mulching (Myśliwiec 1992). However, a disadvantageous effect of using black nonwoven crop cover is lower extract content in fruit by over 4% (Grajkowski et al. 2010).

The Laboratory of Pomology in the West Pomeranian University of Technology has been conducting experiments in the area of grapevine growing for several years. The aim of this research is the determination of the influence of soil mulching and the method of cutting and shaping the grapevine on the quality and size of the yield.

MATERIALS AND METHODS

The tests were performed in the Horticulture Department of the West Pomeranian University of Technology, Szczecin. The Research Station is located in the Szczecińska Lowland. In this area, there are numerous hills of 20–60 m ASL, the remnants of the frontal moraine. This affects the distribution of rainfall intensity, number of hours of sunlight, temperature and wind speed. The climate of this area is also significantly affected by the presence of large water basins (Szczecin Lagoon, Dąbie Lake, the Odra River), which provide additional moisture in the period of plant vegetation. The plant material was the vines of ‘Regent’ cultivar, grafted to the rootstock Kober 125 AA125 (*V. berlandieri* x *V. riparia)*.

Shrubs were planted in 2006 at a spacing of 2.3 x 1.2 m in three replications on three shrubs in a random subblock system in a brown podsolic soil rich in the nutrients (Table 1), thus only nitrogen fertilization was performed at the total dose of 60 kg N per ha and magnesium sulphate of 50 kg per ha. Additionally, the plants were sprayed three times with 1% magnesium sulphate. The doses of water and the dates of their application were established by using a tensiometer. Suction force of the soil was maintained at about 1.5–2.2 pF. Plants were trained in the form of a single Gujot system.

Table 1. The pH and the content of the components in the soil before planting shrubs
Tabela 1. Odczyn oraz zawartość składników mineralnych w glebie przed posadzeniem roślin

Level of soil (cm) Poziom gleby	pH KCl	Need for liming Potrzeba wapnowania	P	K	Mg
			mg 100 g soil mg 100 g gleby		
0–30	6.92	unnecessary zbędne	6.8	7.3	7.1
30–60	7.06	unnecessary zbędne	4.3	6.9	5.6

'Regent' grapes are a German cultivar medium frost resistant (Lisek 2007), high-yielding and with early fructification. It produces medium-sized clusters with densely packed, globular, small berries which are rarely of medium size and higher resistance to fungal diseases (Eibach and Toepfer 2003, Fischer et al. 2004). The fruit peel is dark blue and black, and the pulp is colorless. The berries become discolored at the beginning of September and ripen in early October.

Experiment plan:

Factor I – soil tillage:

– mulched soil (dark plastic),
– conventional tillage (lack of cover).

Factor II – method of vine training:

– vines trained to 1 fruit cane with 6 buds,
– vines trained to 1 fruit cane with 10 buds.

The experiment consisted in the comparison of: yield, the size of clusters and fruit, their chemical composition and color. The cluster and fruit weight, fruit detachment force, firmness, color, soluble solids, titratable acidity were measured on fresh berries soon after each harvest. The fruit weight (three replicates of 100 fruits) was measured with RADWAG WPX 4500 electronic scales (0.01 g accuracy). To obtain juice, the berries (two replicates of 500 g) were macerated at 50ºC with the addition of the PT 400 Pektopol enzyme at a dose of 400 mg per kg of fruits for 30 minutes. After the completion of the enzymatic processing, the pulp was pressed using a hydraulic press at a pressure of 3 MPa. Titratable acidity and pH were determined by titration of a water extract of juice with 0.1 N NaOH to an end point of pH 8.1 (measured with a multimeter Elmetron CX-732) according to PN-90/A-75101/04.

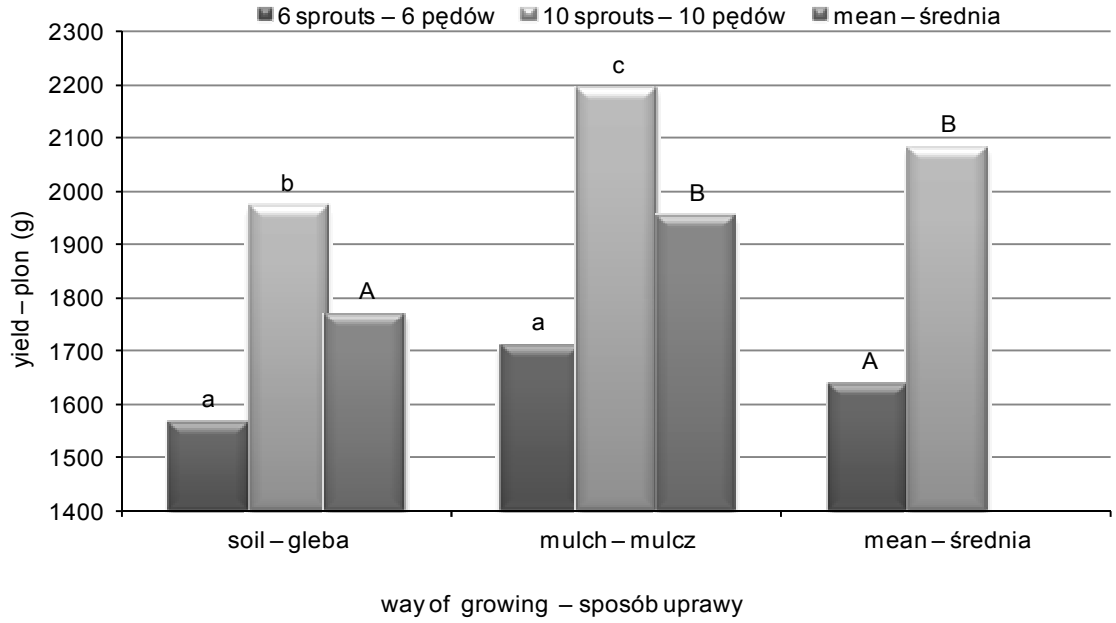
Soluble solids content was determined by a digital refractometer PAL-1 (Atago, Japan). Nitrates content was measured with a RQflex 10 reflectometer (Merck). Fruit color (three replicates of 50 fruits) were measured in a transmitted mode through Konica Minolta CM-700d spectrophotometer in 1 cm-thick glass trays. Measurements were conducted in CIE L*a*b* system [L* white (100) black (0), a* green (–100) red (+100), b* blue (–100)

yellow (+100)], through a 10º observer type and D65 illuminant. CP Pigment Analyzer PA1101 (Produced by Control in Applied Physiology GbR., Germany) was used for non-destructive measurement of quality parameters. Spectra collected from CP PA1101 were used for calculating Normalized Anthocyanin Index NAI = (*I780-I570*)/(*I780+I570*). The firmness was measured with a FirmTech 2 apparatus (BioWorks, USA) of 50 randomly selected berries from three replicates and was expressed as a gram-force causing fruit surface to bend 1 mm, and each of the obtained results has been used in the statistical analysis.

The results obtained were subjected to statistical analysis using Statistica 10 (Statsoft, Poland). The results evaluated by the Tukey test. The differences between the means at $P<0.05$ were considered as significant.

RESULTS AND DISCUSSION

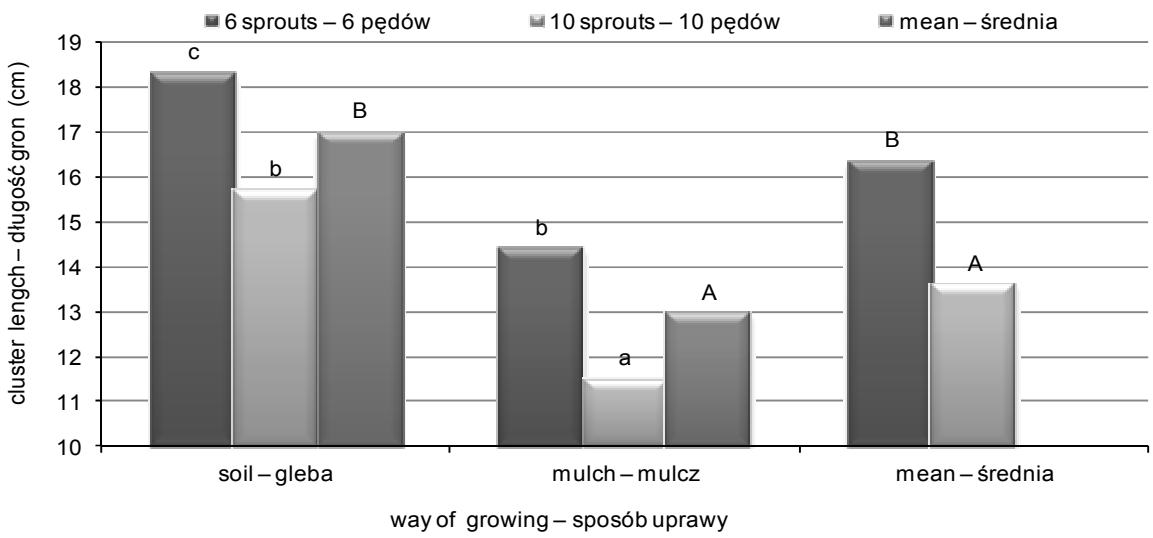
The results of tests on the 'Regent' grapevine cultivar indicate that pruning and tillage affect the yield (Fig. 1).



Means marked with the same letter do not differ significantly at α = 0.05 according to Tuckey test. Small letters marked significant differences factors and capital mean.
Średnie oznaczone tą samą literą nie różnią się istotnie według testu Tuckeya na poziomie istotności α = 0,05. Małymi literami oznaczone istotne różnice pomiędzy czynnikami, a wielkimi średnie.

Fig. 1. The impact of tillage on the yielding of the Regent cultivar of vines
Rys. 1. Wpływ sposobu uprawy na plonowanie winorośli odmiany Regent

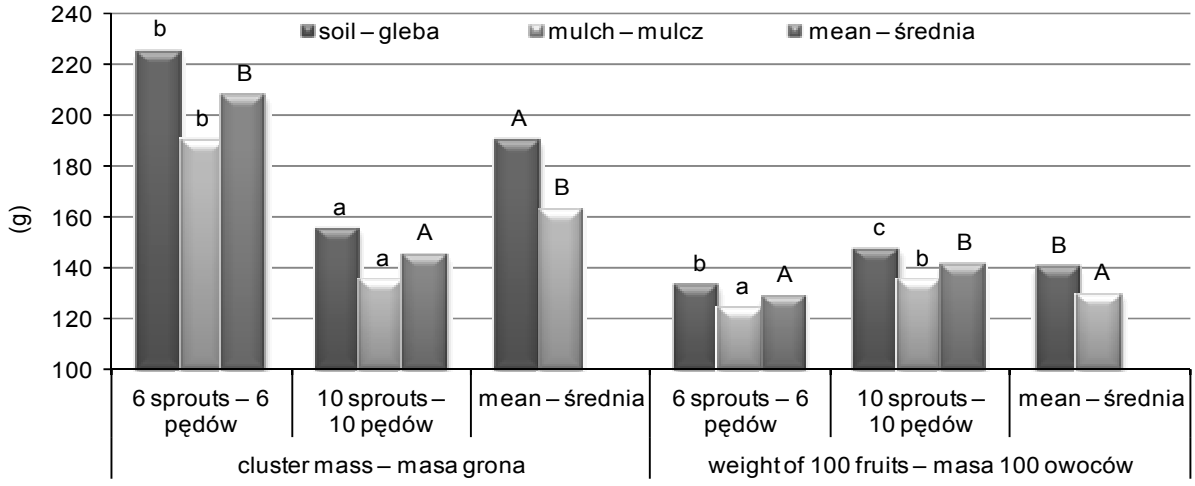
It was observed that mulched vine plants give a higher yield (1950 g) than the non-mulched (1760 g). Likewise, the vines grown with more shoots yield a harvest of 2.2 kg of fruit per plant. However, the clusters were bigger when the vines were trained to 6-shoot canes in the non-mulched soil – 18.3 cm (Fig. 2). In addition, it was determined that the weight of a single cluster is higher for the vines planted in the non-mulched soil – 225 g (Fig. 3).



Explanation see Fig. 1 – Wyjaśnienie patrz Fig. 1.

Fig. 2. The impact of the number of shoots per cane and soil row tillage on the length of the Regent cultivar of clusters

Rys. 2. Wpływ liczby pędów na łozie oraz sposobu uprawy gleby w rzędach na długość gron odmiany Regent



Explanation see Fig. 1 – Wyjaśnienie patrz Fig. 1.

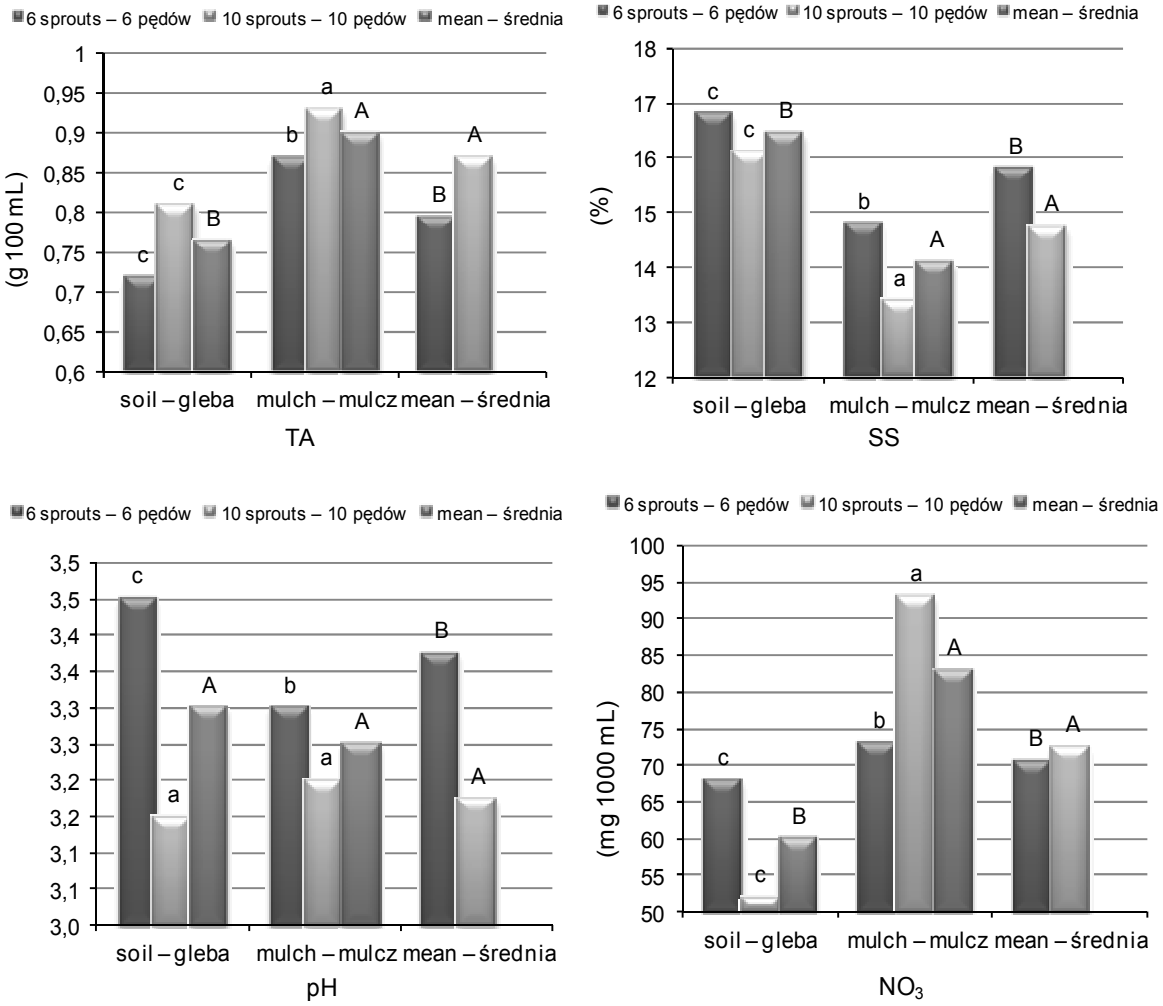
Fig. 3. The impact of the number of shoots per cane and soil row tillage on the cluster weight and weight of 100 fruit of Regent cultivar

Rys. 3. Wpływ liczby pędów na łozie oraz sposobu uprawy gleby w rzędach na masę gron oraz masę 100 owoców odmiany Regent

The size of the fruit is of significance in the process of wine production and detachment of the fruit from the peduncle. Knowledge of these parameters is needed to determine the parameters for the process of separating fruit from the stalk. As stated by Gembara (2008) and Lisek (2011), the clusters of 'Regent' cultivar are quite compact, with densely packed berries, and of medium size. Senator (2007) determined that the average cluster weight ranges from 120 to 140 g, and that such a load is optimal for one cane, as any greater weight would result in the deterioration of the yield quality.

Based on the analysis of results (Fig. 3) relating to the soil tillage, it was observed that the use of row cover led to the reduced cluster weight (mulch 162 g, soil 190 g), the fruits were smaller; weight of 100 fruit with mulch bushes 126 g and non-mulch 144 g. According to Myśliwiec (1992), the application of a black plastic in rows is advantageous, particularly to the growth of young plants.

It should be emphasized that Polish winemakers strive to obtain the highest content of extract in fruit, which is difficult to achieve in Poland due to the country's low temperatures and insufficient sunshine duration. According to Markowski and Płocharski (2003), in assessing the usefulness of fruit for processing, an important factor for consideration is the content of the extract in fruit. It is assumed that non-sugar compounds constitute between 2 and 4% of the extract. The vine fruit quality, expressed in the content of extract, as shown in Figure 4, depended on the tillage and was better for non-mulched soils.

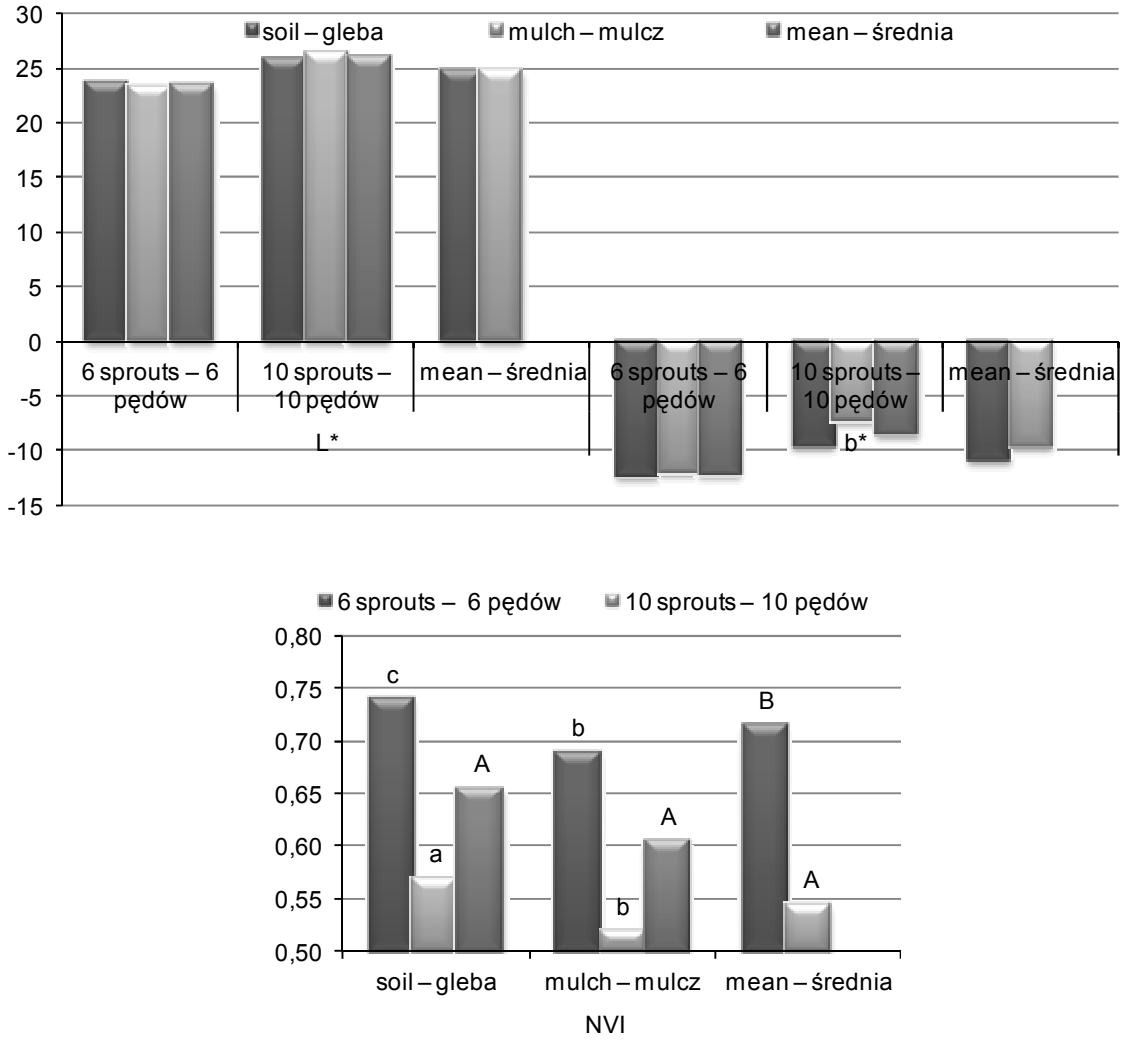


Explanation see Fig. 1 – Wyjaśnienie patrz Fig. 1.

Fig. 4. The impact of the number of shoots and method of soil row tillage on the chemical composition of the fruits of Regent cultivar; TA – titratable acidity, SS – soluble solids

Rys. 4. Wpływ liczby pędów na łozie oraz sposobu uprawy gleby w rzędach na skład chemiczny owoców odmiany Regent: TA – kwasowość, SS – ekstrakt

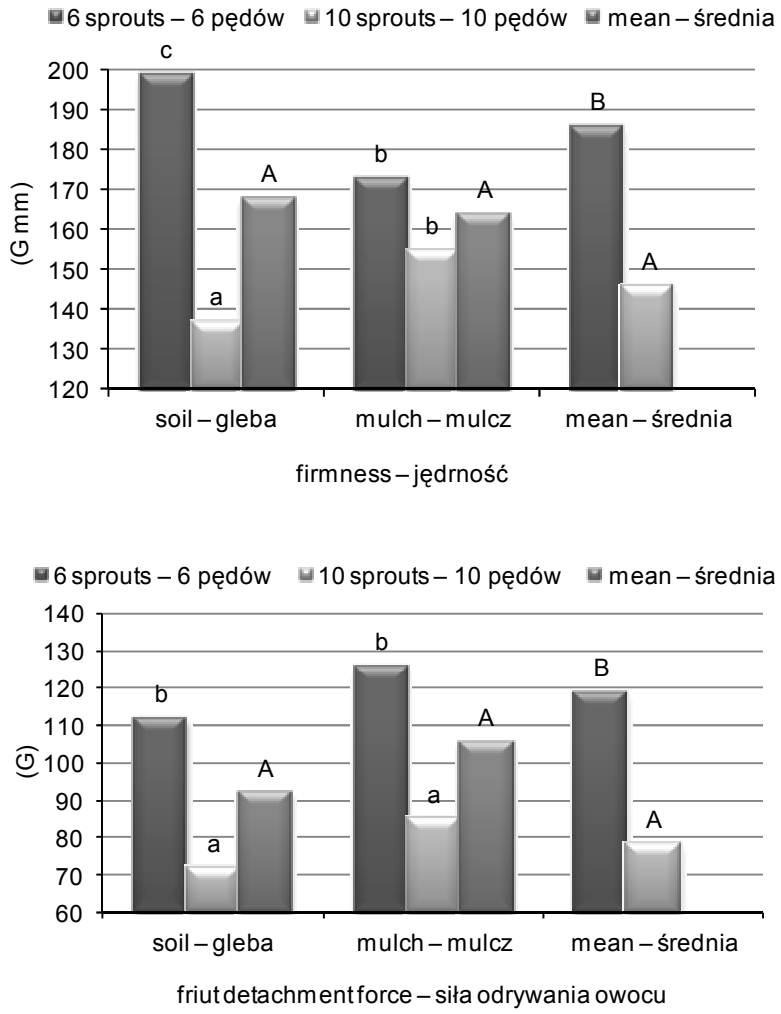
The results of analyses indicate that the highest concentration of extract was found in the vine fruits of 'Regent' cultivar, derived from the vines cultivated in non-mulched soil, trained to 6 shoots (16.9%) and 10 shoots (16.1%). The lowest extract content was determined for the fruit of the same cultivar, derived from the vine plants trained to 10 shoots, planted in mulched soil (13.4%). The fruits of the plants from mulched rows were less ripe, as shown by their higher content of nitrates – 83 mg, higher acidity – 0.9 g in 100 g fruit (Fig. 4), a lower blue dye content (b *parameter –9,69) and a lower value of NVI – 0.61, as compared to the non-mulched (Fig. 5).



Explanation see Fig. 1 – Wyjaśnienie patrz Fig. 1.

Fig. 5. Fruit color and NVI index of the Regent cultivar vines
Rys. 5. Barwa oraz indeks NVI owoców winorośli odmiany Regent

Cane pruning caused the reduction of the fruit mass (Fig. 3), owing to which the fruit were firmer (186 G mm) than the fruit derived from 10-shoot canes (145 G mm), and a higher fruit detachment force was required – 119 G, compared to 10-shoot canes – 78 G (Fig. 6).



Explanation see Fig. 1 – Wyjaśnienie patrz Fig. 1.

Fig. 6. Firmness and fruit detachment force (from the peduncle)
Rys. 6. Jędrność oraz siła odrywania owocu od szypułki

In addition, such fruit contained less extract (15.8%), had a higher juice pH (3.38) and lower acidity (0.79 g) (Fig. 4), was darker in colour (L* 23.5), with a higher content of blue dye (b* parameter –12.2) and was characterized by a higher NVI indicator (0.72) (Fig. 5).

Based on several years of research, Grajkowski et al. (2010) reached the conclusion that mulching the rows with the use of a nonwoven crop cover has a negative impact on the quality of fruit of the 'Regent' cultivar. There was a decrease in the extract content by about 4% in comparison with the conventional tillage. They conducted an experiment that showed that the lowest level of extract was determined in the sample derived from the tillage, for which the vines were trained to 10 shoots and covered with black plastic, whereas the lowest results were achieved with respect to the non-cover tillage, where the vines were trained to 6 shoots. Slightly different results were obtained in the experiment carried out by

Ochmian et al. (2011). The measurements were made directly after the harvest and indicated that the content of extract in the fruit of 'Regent' cultivar was 19.3%. Such a high content of extract could have resulted from favorable weather conditions at the time of fruit ripening. In the study of Lisek (2010) cluster was characterized by lower weight (137 g) and the greater weight of 100 fruits, and amounted to 215 g. Extract content was also higher (19.6%).

CONCLUSIONS

1. In the vineyard of 'Regent' cultivar, the application of mulching resulted in an increase of yield, but proved to be detrimental to its quality.
2. Training of cane to six shoots led to the achievement of longer clusters of higher mass as compared to the clusters of 10-shoot canes.
3. The training of shorter canes results in better light conditions for plants, which led to a higher extract content in the vine fruit and reduction of nitrate content, as compared to the canes trained to 10 shoots.
4. The vines trained to 6-shoot canes have darker fruit (L* parameter), with a higher content of blue dye (b* parameter), are firmer and require the application of a greater fruit detachment force.
5. Mulching resulted in the deterioration of fruit ripening, which in turn led to such fruit having higher acidity, a lower extract content and lower pH, as well as a higher content of nitrates, as compared to the non-mulched plants.

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Abstract. The tests were performed in the years 2010–2011 in the Laboratory of Pomology at the West Pomeranian University of Technology in Szczecin. The tests concerned the impact of soil mulching and the number of shoots per vine cane on the quality and yield of the vines of the 'Regent' cultivar, grafted to the rootstock Kober 125 (AA125). Vines of the III valuation class were planted in clay soil. Soil mulching turned out to be disadvantageous, resulting in the deterioration of fruit quality. Grapes contained less extract (14.1%), more organic acids (0.90 g) and nitrates (83 mg) and had a lower pH (3.25) in the juice in comparison with the non-mulched plants. Pruning the cane to six buds resulted in clusters that are bigger in size (16.4 cm) and mass (208 g) than those obtained from ten-bud canes. Training vines to shorter canes resulted in better light conditions for plants, which in turn led to an increase of the extract content in fruits (15.8%) and decrease of nitrates (71 mg); fruits were firmer (186 G), darker (L* parameter; 23.54) and contained more substances giving a blue color (b* parameter; –12.19). However, they required a higher fruit detachment force – 119 G (from the peduncle).