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IMPACT OF SOIL MANAGEMENT SYSTEMS ON THE CHEMICAL COMPOSITION OF FRESH PLUM FRUIT OF 'KATINKA' CULTIVAR

Georgi POPSKI, Boryana STEFANOVA, Petko MINKOV

Institute of Mountain Stockbreeding and Agricultire Troyan, 281 Vasil Levski Str., Troyan, 5600, Bulgaria

Corresponding author email: g.popski@abv.bg

Abstract

The chemical composition of fresh plum fruits of 'Katinka' cultivar was studied for a 5-year period (2015-2020) in an experimental plum plantation of RIMSA Troyan. The soil surface in the plantation is maintained in three treatments - black fallow, natural grassland and artificial grassland. It was found that the content of dry matter and acids in the fruits of 'Katinka' were not affected by the way the soil surface was managed. These indicators varied relatively little over the years, in the range of less than 1.5% for dry matter and from 0.41% to 0.82% for acids. There was a higher percentage of total sugars in fruits in the artificial grassland for all years of the study period and varied from 9.05% to 11.60%. The most favourable values for the ratio between sugar and acids in fruits (glucoacidimetric coefficient) were reported in the artificial grassland, which is important for the formation of good taste qualities of the fruits with variation over the years from 13.89-27.07. In the case of fallow and natural grassland treatments, a high correlation dependence was established between the content of organic acids and inverted sugar.

Key words: *Plum, cv. 'Katinka', chemical parameters, soil management systems.*

INTRODUCTION

The plum crops occupy a major place in the foothills and mountain regions of Bulgaria. These are most often areas with sloping terrain, threatened by the development of water erosion. Overcoming the negative consequences of sloping terrain depends on the soil surface management systems. With a properly chosen management system, the risk of erosion can be reduced, soil fertility can be increased and good growth and high and quality yields of fruit plants can be ensured (Bozhanska et al., 2019, 2017; Hristova et al., 2017).

The impact of various soil management systems have been studying in the Research Institute of Mountain Stockbreeding and Agriculture for decades, monitoring their impact on tree reproductive capacity and fruit quality (Dinkova et al., 2004; Gergov et al., 2001).

Modern fruit production requires compliance with the quality requirements of fresh plums, according to European regulations (MAF, 2004).

The composition of the chemical elements in plums varies primarily depending on the cultivar, ecological conditions, the location of the garden and the latitude of a given area (Dzhuvinov et al., 2012).

Plums are rich in sugars, organic acids, tannins and dyes, pectin, vitamins and minerals.

An important indicator of fruit quality is the dry matter content.

Walkowiak-Tomczak et al. (2007) and Sosna (2010, 2012) found that plum genotypes had a significant effect on dry matter. Our results on the dry matter content of 'Katinka' cultivar are similar to those obtained by Blažek & PištΘkova (2009) and Milošević et al. (2012) for the same plum cultivar grown in the Czech Republic and Serbia respectively.

According to some scientists, the differences in sugar content in plums are due to different agro-climatic conditions (Nergiz & Yldz, 1997). According to others, the cultivar itself affects the sugar profile in fruits (Crisosto et al., 2004).

A summary indicator of the fruit chemical composition is the glucoacidimetric coefficient

(the ratio between sugars and acids). It largely determines the fruit taste (Minev, 2002). According to Forni et al. (1992) the ratio between sugars and acids for good quality plums should be between 12-24. Our studies correspond to various studies, according to which the fruits of 'Katinka' cultivar have a good balance between sugars and acids (Milošević, et al., 2012) and are recommended mainly for fresh consumption, but are also suitable for processing and drying (Hartmann & Neumüller, 2006).

The objective of the present study is to establish the impact of different soil management systems on the chemical composition of fresh plums of 'Katinka' cultivar.

MATERIALS AND METHODS

The experiment was carried out in 2015-2020 at RIMSA-Troyan in a plum plantation of 'Katinka' cultivar, established in 2010 in an area of 8 da, on a pseudopodzolic soil, poorly stocked with nutrients. The exposure is northwestern with a slope of 4-5°. The planting pattern is 5 x 3 m.

The soil surface is managed in three variants:

1. Fallow - the inter-rows are maintained as a fallow by disking;
2. Natural grassland - the interrows are covered by turfgrass of natural perennial grasses;
3. Artificial grassland - interrows are covered by turfgrass of grass mixture from legume and grasses in ratio (1:1) with bird's-foot-trefoil and red fescue at a seeding rate of 5 kg/da.

The observation of the chemical composition of fresh fruits of 'Katinka' was conducted in the chemical laboratory of RIMSA-Troyan according to the following methods:

- dry matter according to Re (%);
- sugars (%) total, inverted and sucrose – according to Schoorl Regenbogen method;
- acids (%) - by titration with 0.1n NaOH;
- vitamin C (mg/%) - according to Fialkov method;
- anthocyanins (mg %) - according to Fuleki and Franciss method;
- tanning substances (%) - according to Levental method.

By mathematical data processing with ANOVA program in Excel, the dependences of correlation and regression among chemical elements in the different soil management variants were calculated.

RESULTS AND DISCUSSIONS

During the years of the study, no significant differences were found in terms of dry matter fruit content, depending on the soil surface management system. The clearest difference was in 2016 (4.9%), 1.5% in 2015 and 2017, for 2018 it was below 0.1% among the different variants. During the extremely dry year 2020, with the average amount of precipitation 386.2 mm, there was no difference - 15% in all variants (Table 1). The coefficient of variation was low 10.21%.

The dry matter content in the fruits of 'Katinka' variety was low during the whole period of research in all three variants. This corresponds to the data of Iliev (1988), Milosevic et al. (2012), according to which plum cultivars with early ripening period have a low dry matter content in the range of 12.75 to 17.53%; Zavisic end Rosic (2017) set the dry matter content in 'Katinka' fruits to 13%.

Carbohydrates are a major part of fruit dry matter, and the soluble sugars are the largest share of them. The plum fruits of 'Katinka' cultivar differ in the content of total sugars depending on the soil surface management systems. The highest percentage of total sugars was reported in the variant with artificial grassland (9.05-11.60%), followed by the fallow (7.85-11.30%), and the lowest content was in the variant with natural grassland (7.50-11.10%), with a low coefficient of variation 12.32%. During the years of the study, the content of sucrose and inverted sugar in fruits of 'Katinka' cultivar varied in very wide ranges of 3.70-6.85% (inverted sugar) and 1.43-5.94% (sucrose) with a coefficient of variation of 13.76% for inverted sugar and 33.27% for sucrose.

Table 1. Chemical analysis of fresh plums in different variants

	Soluble Solids (%)	Total sugars (%)	Inverted sugars (%)	Sucrose (%)	Acids (%)	Glucoacidimetric index	vit. C (mg/%)	Tanning Substances (%)	Anthocyanins (mg/%)
2015									
1. Clean cultivation	13.50	9.05	3.70	5.08	0.35	25.86	3.52	0.104	17.42
2. Natural grassland	14.50	8.55	5.50	2.90	0.38	22.50	2.64	0.104	21.94
3. Artificial grassland	15.00	11.10	6.15	4.70	0.41	27.07	1.76	0.187	18.06
2016									
1. Clean cultivation	11.00	10.25	5.35	4.66	0.58	17.67	3.52	0.208	9.68
2. Natural grassland	15.70	9.90	5.20	4.47	0.45	22.00	6.16	0.187	15.00
3. Artificial grassland	15.90	10.75	4.50	5.94	0.45	23.89	4.40	0.187	8.71
2017									
1. Clean cultivation	14.00	11.30	6.35	4.70	0.62	18.23	8.80	0.056	8.87
2. Natural grassland	12.50	11.10	6.50	4.37	0.75	14.80	8.80	0.094	7.26
3. Artificial grassland	13.00	11.60	6.50	4.85	0.82	14.15	8.80	0.150	16.13
2018									
1. Clean cultivation	12.40	9.62	5.85	3.60	0.64	15.03	10.56	0.037	1.29
2. Natural grassland	12.50	9.55	5.85	3.52	0.57	16.75	10.56	0.056	0.48
3. Artificial grassland	12.50	9.90	5.85	3.85	0.64	15.47	8.80	0.075	3.23
2020									
1. Clean cultivation	15.00	7.85	6.15	1.62	0.60	13.08	14.08	0.145	14.35
2. Natural grassland	15.00	7.50	6.00	1.43	0.54	15.08	15.84	0.208	16.13
3. Artificial grassland	15.00	9.05	6.85	2.09	0.60	13.89	15.84	0.166	22.26
Average (2015-2020)	*13.83*	*9.80*	*5.75*	*3.85*	*0.56*	*18.36*	*8.27*	*0.130*	*12.05*
St. Dev. (2015-2020)	*1.41*	*1.21*	*0.79*	*1.28*	*0.13*	*4.51*	*4.46*	*0.06*	*6.79*
CV% (2015-2020)	*10.21*	*12.32*	*13.76*	*33.27*	*22.93*	*24.54*	*53.94*	*43.69*	*56.33*

Comparing the soil management methods, a slightly higher percentage (invert sugared and sucrose) was reported in the variant with artificial grassland, but these differences were insignificant for each year, with differences below one percent, except for 2015 with a difference of 2-3%.

Of the organic acids, malic predominates, the amount of which was from 0.35% in the fallow variant in 2015, to 0.82% in the artificial grassland in 2017 (CV = 22.93%).

The content of vitamin C in the fruits by years, according to the different variants of soil management, had similar values, with a difference of less than 2 mg/%. The lowest 1.76 mg/% and the highest 15.84 mg/% amount of vitamin C was reported in the artificial grassland variant, with a high coefficient of variation of 53.94%.

Tanning substance, which are most often tannins, have a specific effect on fruit taste. Their variation is the largest (43.69%) in the fruits in black fallow management system - from 0.037% (2018) to 0.208% (2016).

The presence of anthocyanins in plums has a positive effect on their healing properties. Significant differences were observed in terms of their values over the individual years. The highest value was reported in the artificial grassland with 22.26 mg% (2020), and the lowest in the fallow variant 0.48 mg% (2018). They had the highest coefficient of variation of 56.33%.

Fruit taste quality is one of the most important indicators characterizing the fruit cultivars. The fruits of plum cultivars containing sugars from 11% to 17% and not a high percentage of acidity from 0.16% to 0.74% With regard to acids, the fruits during all the years of the studied period in the different variants of soil management varied within these limits. Sugars only in 2017 are approaching the optimal values of 11%.

In a study of the chemical composition of plum fruits, Miloševi et al. (2012) found that 'Katinka' variety had the best characteristics between sugars and acids, compared to other German cultivars for the conditions of Serbia. Our experiments show that in the case of artificial grasslands the ratio of sugars and acids was close to the optimal values for the formation of good fruit taste, with a variation of the glucoacidimetric coefficient of 13.89-27.07 for the study period. The lowest value was reported for the fallow variant in the dry 2020 - 13.08, while for the grassed variants the values were higher 15.08% for the natural grassland and 13.89 for the artificial grassland.

For the period of the study, the indicators of the chemical composition of the fruits of 'Katinka' varied widely, as the average values in our study correspond to those of an eight-year period of research conducted by Iliev et al. (1977) for 'Kyustendilska sinia sliva' and 'Stanley' cultivars.

A high correlation was found between the acid content in fruits, in relation to the inverted sugar (r = 0.9521) in the fallow variant on the function y = 8.5556x + 0.0706, with regression coefficient R^2 = 0.9066 (Figure 1) and in the natural grassland variant (r = 0.9015), by the function y = 318516x + 4.0964 with regression coefficient R^2 = 0.8128 (Figure 2).

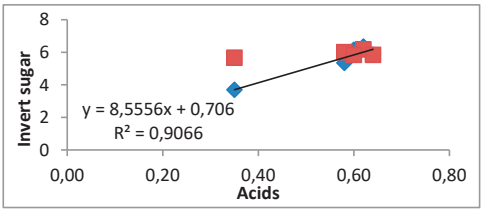

Figure 1. Graphic model of regression dependence between the content of acids and inverted sugar in fruit in clean cultivation

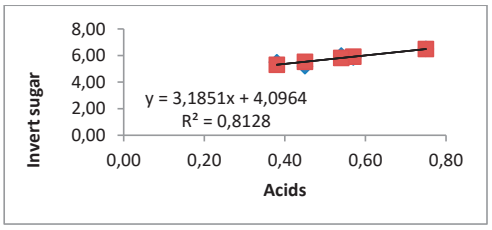

Figure 2. Graphic model of regression dependence between the content of acids and inverted sugar in the fruit in natural grassland

In the third variant (artificial grassland), there was a high correlation (r = 0.8595) and regression dependence (R^2 = 0.7388) between the content of tanning substances in fruit, by the function y = 27.012x + 10.147, relative to the dry matter, which is easily determined refractometrically (Figure 3).

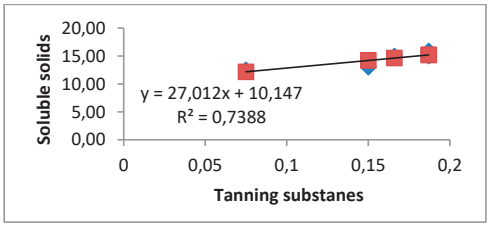

Figure 3. Graphic model of regression dependence between the content of tanning substances and soluble solids in the fruit in artificial grassland

CONCLUSIONS

The content of dry matter and acids in fruits of 'Katinka' cultivar was not affected by the soil surface management system (fallow, natural and artificial grassland) for the respective year.

When maintaining the soil surface in artificial grassland, the content of total sugars in fruit was higher 9.05-11.60%, compared to other variant. A similar trend is observed for inverted sugar (4.50-6.85%) and sucrose (2.09-5.94%).

In all studied variants, for the period 2015-2020 the ratio between sugar and acids (glucoacidimetric coefficient) was on average 18, which determines fruit taste qualities of 'Katinka' cultivar as good.

In the case of fallow and natural grassland, a high correlation dependence was established between the content of organic acids and inverted sugar.

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