Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 1, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

IMPACT OF SOIL MAINTENANCE SYSTEMS ON THE VEGETATIVE AND REPRODUCTIVE MANIFESTATIONS OF 'KATINKA' CULTIVAR

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Abstract

The study was conducted in RIMSA-Troyan in the period 2014-2018, in a plum plantation of 'Katinka' cultivar, under non-irrigated conditions, on pseudo-podzolic gray forest soils, poorly stocked with nutrients. The impact of different soil surface management systems (fallow, natural grassland, artificial grassland) on vegetative and reproductive indicators of plum trees was observed. Data showed that the largest growth of the trunks was registered in soil managed as an artificial grassland (trunk section 2014-30.01cm²; 2015-39.01cm²; 2017-60.56cm²; 2018-70.92cm²) and the highest annual growth was observed for each year of the study period, formed by higher number of annual twigs. In the formation of the volume and projection of the crowns, no patterns have been established regarding the soil management way. The highest yields were reported in 2017 with 14 kg/tree and in 2018 with 9.1 kg/tree from an artificial turf as a soil management system, which had a positive effect on other reproductive indicators, such as weight and size of fruit.

Key words*: plum, soil management systems, growth manifestations, reproduction.*

INTRODUCTION

The plum is widespread throughout Bulgaria. The main plum plantations are located in the semi-mountain and mountain regions of Bulgaria. In addition to agrotechnical events, the system of soil surface menagement system is of major significance for the good development and optimal fruit bearing of trees (Dinkova et al., 2005; Taseva, 2005; Petrov et al., 2008).

The most widely used systems for soil surface management systems in the orchards of Bulgaria are fallow and natural grassing. Prolonged soil management as a fallow land, especially without the introduction of organic matter, dramatically impairs its agrophysical characteristics (Merwin, 2004). Natural grass-cover is a preferred system that has a positive effect on erosion processes, especially in mountain and semi-mountain areas of Bulgaria with wet soils and sloping terrain (Gergov et al., 2001; Petrov et al., 2008).

In recent years, modern fruit growing has introduced environmentally friendly systems related to improving soil fertility, maintaining nutrient balance and limiting erosion through artificial grass-cover of rows and inter-row spacings and rows with legume species (Fiener & Auerswald, 2007; Watson & Evans, 2007; Prasuhn, 2012; Poláková et al., 2018).

For the mountain conditions of Bulgaria, the mixture of common bird's-foot-trefoil (*Lotus corniculatus* L.) with red fescue (*Festuca rubra* L.) and Kenthucky bluegrass (*Poa pratensis* L.) is determined as the most suitable for grass-covering of raspberries, blackcurrants and plums plantations (Petrov & Minkov, 2006; Vitanova & Petrov, 2010; Bozhanska et al., 2019).

The turf-mulched system and living mulch have a slight inhibitory effect on the growth of plum trees, and the fruit bearing is not significantly reduced (Dinkova et al., 2004).

Applying a properly selected soil menagement system can ensure good growth, quality and high yields of fruit plants, reduce erosion processes, improve soil fertility and ensure optimal nutrition (Bozhanska et al., 2019, 2017; Hristova et al., 2017).

A number of scientists have studied biologically and economically viable systems for soil surface management and their impact on the growth, development and fruit bearing of fruit crops (Glenn & Welker, 1989; Merwin et al., 1994; Parker & Meyer, 1996; Neilsen et al., 1999; Miletic et al., 2010)

The research workers at RIMSA Troyan have been working for decades on the study of appropriate environmentally friendly systems for soil surface management in plum plantations (Gergov et al., 1998; Dinkova et al., 2004), monitoring their impact on vegetative and reproductive capabilities of trees and fruit quality (Petrov & Dinkova, 2004; Dinkova & Petrov, 2004).
The aim of the present study is to determine how the different soil surface management systems affect the vegetative and reproductive manifestations of 'Katika' plum cultivar.

MATERIALS AND METHODS

To study the impact of different systems of soil surface management on the growth and reproductive performance of plum trees, an experiment with the following variants was set in Troyan RIMSA:

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

The experiment was conducted in 2014-2018 in a plum orchard with 'Katinka', grafted on a Fereley rootstock, established in 2010, on pseudo-podzolic soils with poor nutrient soils. Inter-row spacings were covered with turf (Natural grassland, Artificial grassland) in 2013.
The vegetative and reproductive indicators of the fruit trees are taken into account, in the different variants of soil management:

- Trunk cross section (cm^2); Crown volume (m^3); Crown projection (m^2); Annual shoot length growth (cm); Total annual shoot length growth (cm); Number Annual shoot length;
- Fruit weight (g); Fruit stone (g); Yield per tree (kg); Fruit stone (% of the fruit); Fruit and stone dimensions (mm);

RESULTS AND DISCUSSIONS

Inter-row spacings was covered by turf and sown with grass species in 2013. Their impact on the vegetative and reproductive indicators of the trees was evident after 2014, when they reached the optimal for their species root system and aboveground mass.
In the first two years of the experiment (2014-2015), there was a large increase in the trunk cross section of the trees from the artificial grassland variant, followed by the fallow variant.
In 2016 the trees of the three variants are approximately equal in trunk cross-section, but in natural grassland there was a maximum trumk increase by 18 cm^2, compared to 2015. In the next two years (2017-2018), a larger increase was observed in the trunks of the grass-covered variants, as the largest was in trees grown on artificial grassland in 2017 (60.56 cm^2), 2018 (70.92 cm^2) (Table 1).

Table 1. Vegetative characteristics of trees (2014-2018)

		Trunk cross section (cm^2)	Crown volume (m^3)	Crown projection (m^2)	Annual shoot length growth (cm)	Total annual shoot length growth (cm)	Number Annual shoot length
2014	Clean cultivation	26.88	1.16	1.43	38.51	401.17	10.42
	Natural grassland	25.98	1.48	1.58	31.07	513.69	16.53
	Artificial grassland	30.1	2.35	2.25	37.73	1007.91	26.71
2015	Clean cultivation	36.31	4.42	4.69	29.14	305.67	10.49
	Natural grassland	31.56	4.8	4.85	33.05	361.00	10.92
	Artificial grassland	39.01	2.82	3.04	43.10	538.67	12.5
2016	Clean cultivation	48.74	3.81	3.56	20.73	370.80	17.89
	Natural grassland	49.6	5.04	4.97	23.50	229.40	9.76
	Artificial grassland	46.22	5.29	4.71	11.00	258.60	23.51
2017	Clean cultivation	50.45	6.30	5.49	26.34	394.20	12.51
	Natural grassland	56.99	7.64	6.39	23.75	319.80	15.00
	Artificial grassland	60.56	5.74	5.73	28.45	359.40	16.80
2018	Clean cultivation	53.17	14.26	11.10	22.35	310.20	14.80
	Natural grassland	68.65	10.13	7.88	21.28	250.60	13.60
	Artificial grassland	70.92	9.49	8.84	24.94	280.50	15.75

The highest increase in trunk cross-section was measured in the artificial grassland management system, in all years of the study.

When the experiment was set in 2014, the trees of the artificial grassland variant had larger crowns (2.35 m^3) and a projection (2.25 m^2).

The following year, these differences were erased, with the volume and projection of the crown lagging behind. In 2016, the volume and the projection had higher values again in the grass-covered variants.

The largest crowns were observed in the fallow management system in 2018 (volume-14.26 m^3; projection-11.10 m^2) (Table 1), as no impact on the shape and volume of the crowns were established in relation to soil surface management system.

According to Costes et al. (2004) the growth that is formed each year is a variable that determines the size of the trees. In the first years of the study (2014-2015), the highest one-year growth was measured in the artificial grassland variant, formed by a larger number of annual twigs, except for 2016, the trend was maintained until the end of the study. Our studies correspond to various studies, according to which grass-covering of inter-row spacing does not negatively affect the growth manifestations of plum trees (Dinkova et al., 2008; Petrov et al., 2008).

The main morphological characteristics of plums are shape, size, weight.

With the gradual entry of the plantation into full fruit bearing, the fruit weight and yields increased annually. The data are presented in Table. 2.

Table 2. Reproductive performance of 'Katinka' cultivar (2015-2018)

Variant	Fruit weight (g)	Fruit stone (g)	Yield per tree (kg)	Fruit stone (% of the fruit)
2015				
Clean cultivation	19.71	0.93	7.22	4.74
Natural grassland	17.83	0.98	7.07	5.49
Artificial grassland	14.51	0.76	6.41	5.22
LSD $_{0.05}$	*1.11*	*0.08*		
St Dev	*2.89*	*0.13*		
2016				
Clean cultivation	18.95	0.88	6.40	4.66
Natural grassland	18.78	0.84	3.90	4.49
Artificial grassland	21.88	0.92	5.80	4.18
LSD $_{0.05}$	*1.51*	*0.08*		
St Dev	*2.35*	*0.90*		
2017				
Clean cultivation	22.36	0.88	6.50	3.92
Natural grassland	23.00	0.91	3.50	3.96
Artificial grassland	24.28	1.01	9.50	4.15
LSD $_{0.05}$	*4.69*	*0.42*		
St Dev	*3.33*	*0.12*		
2018				
Clean cultivation	16.76	0.89	7.90	5.11
Natural grassland	19.32	0.96	7.40	4.98
Artificial grassland	21.18	0.92	9.10	4.34
LSD $_{0.05}$	*1.80*	*0.08*		
St Dev	*2.49*	*0.12*		

The fruit weight varied according to variants and during the years from 14.5 to 24.2 g. These data correspond to Blazek and Pistekova, (2009) where for the conditions of Holovousy, 'Katinka' weighed 21.8 g and variation was 17-24 g. Milatovic et al. (2018) confirmed the weak growth force of 'Katinka', and gave 22.9 g per fruit weight. For the years of the present study, such a weight was reported in 2017, when the fruits were the largest (22.36-24.28), regardless of the soil surface management system. In the same study, 'Katinka' was defined as a high-yielding cultivar. For the Bulgarian conditions the highest yields on average for the three variants were reported in 2018 (7.40-9.10 kg per tree).

The relatively small variation in the stone weight among the different variants by less than 0.2 g is impressive.

In 2015 the highest weight and the highest yield were reported in the fallow variant (Table 2). In the following years the highest fruit weight was measured in the grass-covered variants, as in the artificial grassland larger fruits with higher yield were formed. In 2017, the largest fruit weight of 24.28 g and the highest yield of 9.5 kg/tree were reported for the variant, compared to the other variants for the study period.

Low yields were reported in the natural grassland variant, regardless of the larger size of the fruit, and in 2016 the yield was half less than in the other two variants. This is probably because of some suppression and competition of grass vegetation.

The relative share of stone by variants over the years is 4-5.5%, which is close to most plum cultivars and is not affected by the soil surface management system.

The fruit sizes varied very little, comparing them by variants and years. The stone size varied much less, with a thickness of less than 0.5 mm between variants.

Slight variation in the fruit size and stones shows that they are not affected by the soil management system (Table 3).

Table 3. Sizes of fruit and stone (2015-2018)

	Fruit size (mm)			***Stone fruit size (mm)***		
	height	width	thickness	height	width	thickness
2015						
Clean cultivation	35.20	27.90	28.10	20.40	11.90	6.10
Natural grassland	34.90	28.20	28.00	20.20	12.10	6.20
Artificial grassland	34.50	27.40	27.90	20.80	12.00	5.90
LSD $_{0.05}$	*0.98*	*0.85*	*0.92*	*0.84*	*0.30*	*0.42*
St Dev	*2.68*	*2.29*	*3.14*	*1.26*	*0.39*	*0.60*
2016						
Clean cultivation	36.30	28.60	28.30	20.60	12.50	6.50
Natural grassland	35.80	28.20	28.30	20.80	12.30	6.30
Artificial grassland	38.10	31.00	30.20	21.00	12.50	6.90
LSD $_{0.05}$	*1.25*	*1.43*	*1.46*	*1.39*	*0.74*	*0.52*
St Dev	*2.41*	*2.34*	*2.16*	*1.60*	*0.83*	*0.50*
2017						
Clean cultivation	39.07	32.33	29.87	21.80	13.87	7.00
Natural grassland	39.40	32.67	29.53	22.36	14.13	6.86
Artificial grassland	35.00	35.00	33.33	23.93	14.87	7.00
LSD $_{0.05}$	*3.91*	*2.28*	*1.95*	*2.50*	*1.35*	*0.49*
St Dev	*2.67*	*1.91*	*2.41*	*2.67*	*1.91*	*0.37*
2018						
Clean cultivation	37.27	29.20	27.67	22.46	13.62	6.54
Natural grassland	37.93	30.53	29.53	23.31	13.69	6.77
Artificial grassland	39.40	31.73	30.33	23.08	13.92	6.92
LSD $_{0.05}$	*1.45*	*1.25*	*1.07*	*0.83*	*0.52*	*0.39*
St Dev	*2.49*	*1.93*	*1.70*	*2.21*	*0.72*	*0.51*

For the period of the study, the fruitfullness rate for 'Katinka' was calculated for different soil management systems. In the first year (2015) in all three variants it was higher, as the highest value was registered for the natural grassland variant (0.22 kg/cm^2). In the following years, under the influence of the grass vegetation of the natural grassland, the fruitfullness decreased drastically (Figure 1).

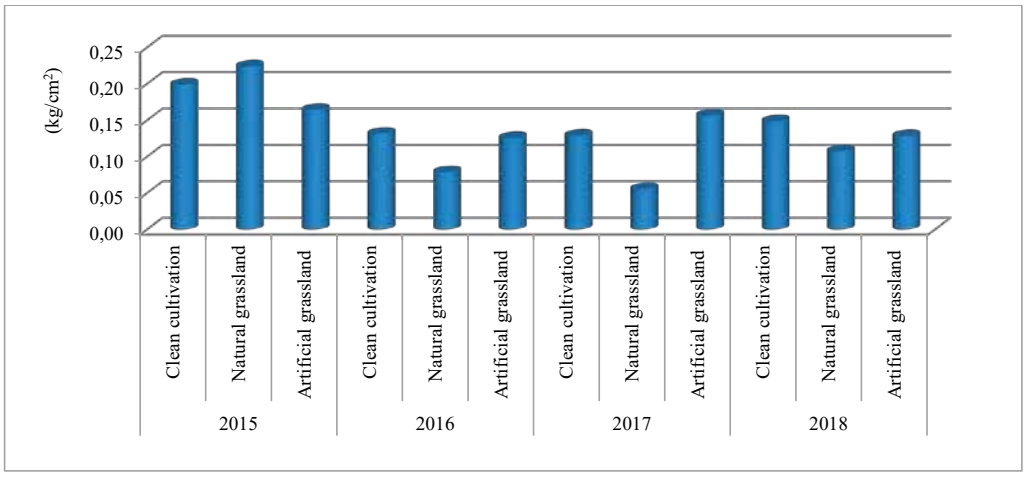

Fig. 1 Fruitfullness coeficient (kg/cm^2) (2015-2018)

CONCLUSIONS

Maintaining the soil surface in artificial grassland had a positive effect on the growth of trees with higher trunk growth and high annual growth, formed by a large number of annual twigs. The volume and projection of the crowns were not affected by the soil management system.

Higher yield formed by fruits with higher weight with high fruitfullness rate was gathered when 'Katinka' was grown on artificial grassland.

Maintaining the inter-row spacing in natural grassland had a negative effect on the reproductive performance of this cultivar due to the competition of grass vegetation.

The highest efficiency on the vegetative and reproductive manifestations of 'Katinka' cultivar was registered in the artificial grassland. This makes this system promising.

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