Mulch and Cultivars Influence on Strawberries Growth and Yield in Open Field Conditions

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Abstract

The research subject of this paper was conducted in Satu Mare County, Romania, where three strawberry cultivars have been studied, namely 'Alba', 'Viktoriana' and 'Camarosa', on two different types of mulch (black mulch and straw mulch). Observations, measurements, and determinations have been made regarding the growing vigor of the bushes, productivity and fruit quality. The productivity analysis favored the 'Camarosa' cultivar as highly productive, which is why this cultivar can be proposed for use in plantations. The different mulch types have significantly influenced the weight of the fruit quality, the highest weight being obtained on the black foil substrate. As for the fruit quality, the 'Camarosa' cultivar, which is very valuable from the qualitative point of view, obtained the highest average value of the sugar content measurements, precisely (8.7°Brix).

Keywords: black mulch, cultivars, strawberry, straw mulch, sugar.

Introduction

Strawberry is a species that has high ecological plasticity and grows in the most varied climatic and soil conditions. Strawberry is the species that is suitable for common field cultivation, but also for culture in protected areas. This biological feature, as well as the strawberry-specific genetic features, make possible for this fruit to be consumed fresh in all seasons of the year (Hoza *et al.*, 2011).

Studies throughout the past decades have compared productivity and yield of plants grown under soilless cultivation and those grown in a more traditional manner without finding significant differences (Paraskevopolou-Paroussi *et al.*, 1995; Tagliavini *et al.*, 2005). Similarly, Recamales *et al.*, (2007), compared the fruit

quality (soluble sugars, organic acids, and mineral content) between soilless (open and closed systems) and traditionally cultivated strawberry plants and found that soilless production resulted in fruit with lower pH and soluble solids. Despite technological differences among soilless systems (open vs. closed), the amount and nature of the substrates that can be employed is vast (peat, sand, gravel, polyurethane foam, expanded polystyrene, geotextiles, perlite, Rockwool, vermiculite, coconut fiber, grape debris, rice husks, solid urban waste, etc.). In this context, efforts are being made proposing by-products from different industrial sectors to be employed as substrates in strawberry soilless cultivations, yet little is known about their impact on the fruit quality.

Table 1. Synthesis of the bush growth (cm) and the width of the midline leaflet (cm) in the three analyzed varieties

Cultivars	Black foil	Straw	Mean of cultivar	Black foil	Straw	Mean of cultivar
Growth of the bush (cm)			The width of the midline leaf (cm)			
Alba	15.1 ^a	14.2 ^b	14.7 ^A	19.9 ^a	17.6 ^b	18.8 ^A
Camarosa	13.2 ^c	12.0 ^d	12.6 ^B	18.5 ^{ab}	17.1 ^b	17.8 ^B
Viktoriana	14.2 ^b	13.9 ^c	14.1 ^A	19.1 ^a	17.0 ^b	18.1 ^B
Mean of mulch system	14.2 ^M	13.4 ^N	-	19.2 ^M	17.2 ^N	-
DS _{5%} mulch system = 0.40			DS _{5%} cvs = 0.30	DS _{5%} mulch system = 0.1 DS _{5%} cvs = 1.4 – 1.5		

Quality in strawberry fruits is a complex trait generally assessed in terms of the balance between sugar and acids, which directly relates to taste and hence consumer acceptability (Cordenunsi *et al.*, 2003; Terry *et al.*, 2007; Giné-Bordonaba and Terry, 2009, 2010), but also in terms of the concentration in bioactive compounds with known health-related properties (Terry *et al.*, 2007; Giné-Bordonaba *et al.*, 2011; Manganaris *et al.*, 2013). Several studies have assessed the role that different production systems, including irrigation techniques, organic and/or conventional cultivation methods have on overall strawberry fruit quality (Wang *et al.*, 2002; Davik *et al.*, 2006; Keutgen and Pawelzik, 2007a,b, 2008; Terry *et al.*, 2007; Hargreaves *et al.*, 2008, 2009). The purpose of the paper was to investigate the influence of mulch and variety on strawberry growth and fructification in field cultivation.

Materials and methods

The biological material used for this experience was represented by three strawberry varieties, 'Alba', 'Viktoriana' and 'Camarosa'. Research of the mulch and cultivars influence on strawberry growth and yield in open field conditions has been conducted in a bifactorial experience. The experimental factors used were: the mulching type and the cultivars type with three graduations. The planting system chosen for the experimental plot was 40 cm between rows and 33 cm between plants within a row. The beds were raised 25 cm from the soil level with drip irrigation lines under de mulch. In order to correspond to such a bifactorial model, there were formed 60 variants in three replication. The following objectives were set: the effect of the variety and the substrate on the uniformity of the fruits: fruit weight (g), fruit diameter (mm) and fruit sugar (°Brix). The results obtained were processed by means of the analysis

of the bifactorial model of the divided plots. To analyze the data, Duncan's multiple comparison test was used.

Results and discussion

The results regarding the growth of the bush (cm) and the width of the midline leaf are shown in Table 1. The cultivar factor influenced the growth of the bushes (cm), the differences of this parameter being significant between the cultivars. The different types of mulch have also significantly influenced the growth of the bushes of the analyzed strawberry varieties, the black mulch being superior to that of straw foil. The leaf width is significantly different between the three varieties. The highest mean leaf width was recorded in the 'Alba' variety, while the 'Camarosa' variety showed the smallest values.

Results of fruit uniformity and fruit weight (g) are shown in Table 2. In the analyzed experiment, the cultivar factor influenced the uniformity of the fruits, the differences for this character being significant between the three varieties. The 'Alba' and 'Viktoriana' presented uniform fruits according to the characteristics of the variety, while 'Camarosa' presented uneven fruits. The mulch types significantly influenced the growth of the bush and its weight, the black foil substrate being superior to the straw substrate. The average fruit weight is 29.3 g in the 'Camarosa' cultivar. Similar results were obtained by Radin *et al.*, (2011) with an average fruit weight between 11.8 g and 12.6 g in the 'Camarosa' cultivar, while in other studies values between 12.79 g and 41.53 g were obtained (Oliveira and Scivittaro, 2009; Antunes *et al.*, 2010; Morales *et al.*, 2010).

The cultivar factor also influenced the diameter of the fruit, the differences for this character being significant between the three varieties. The

Table 2. Synthesis of fruit uniformity and fruit weight (g) in the three analyzed varieties

Cultivars	Black foil	Straw	Mean of cultivar	Black foil	Straw	Mean of cultivar
Fruit uniformity			Fruit weight (g)			
Alba	1.3 ^a	1.3 ^a	1.3 ^A	26.4 ^b	33.2 ^a	29.8 ^A
Camarosa	1.3 ^a	1.1 ^b	1.2 ^B	26.0 ^b	32.5 ^{ab}	29.3 ^B
Viktoriana	1.2 ^a	1.2 ^a	1.2 ^A	26.3 ^b	32.9 ^{ab}	29.6 ^A
Mean of mulch system	1.3 ^M	1.2 ^N	-	26.2 ^N	32.9 ^M	-
DS _{5%} mulch system = 0.1			DS _{5%} cvs = 0.2	DS _{5%} mulch system = 0.1 DS _{5%} cvs = 0.2		

Table 3. Synthesis of the observations regarding the fruit diameter (mm) and fruit sugar content (° Brix) in the three analyzed varieties

Cultivars	Black foil	Straw	Mean of cultivar	Black foil	Straw	Mean of cultivar
Fruit diameter (mm)			Fruit sugar (°Brix)			
Alba	38.0 ^{ab}	41.0 ^a	39.5 ^A	7.7 ^b	7.4 ^b	7.6 ^B
Camarosa	36.6 ^b	37.4 ^b	37.0 ^B	9.0 ^a	8.2 ^{ab}	8.6 ^A
Viktoriana	37.6 ^a	39.7 ^a	38.7 ^A	8.1 ^b	8.1 ^{ab}	8.1 ^A
Mean of mulch system	37.4 ^M	39.4 ^M	-	8.3 ^M	7.9 ^M	-
DS _{5%} mulch system = 2.3			DS _{5%} cvs = 3.3-3.5	DS _{5%} mulch system = 0.7 DS _{5%} cvs = 1.0		

highest average fruit diameter was recorded in the 'Alba' variety, while the 'Camarosa' showed the smallest values. The data on the sugar content is very different between the three varieties. The highest average sugar content was recorded in the 'Camarosa', while the 'Alba' variety showed the lowest value (Tab. 3).

Previous research has shown that sucrose, glucose and fructose concentrations can be altered by certain agronomic practices (Keutgen and Pawelzik, 2007; Terry *et al.*, 2007; Giné-Bordonaba and Terry, 2010), but no information is available regarding substrate influence on changing their level. Generally, increased or reduced accumulation of fruit sugars is the result of osmotic adjustments in plant tissues (Giné-Bordonaba and Terry, 2010). Pedro Palencia *et al.*, (2016) obtained relatively similar results with average glucose and fructose concentrations being higher in the cultivar 'Candonga' (161.5 mg g⁻¹ DW and 168.8 mg g⁻¹, respectively DW), if compared to 'Camarosa' (141.2 mg g⁻¹ DW and 147.3 mg g⁻¹ DW respectively), similar to 'Festival' (148.5 mg g⁻¹ DW and 156.2 mg g⁻¹ DW, respectively). In contrast, no significant differences were found between sucrose concentrations with mean values for the three cultivars of 198.5 mg g⁻¹ DW. In previous studies, sucrose content was also observed to

remain fairly constant among cultivars under different irrigation strategies (Terry *et al.*, 2007; Giné-Bordonaba and Terry, 2010).

Conclusion

The experiment revealed that among the evaluated cultivars the most useful for cultivation in Satu Mare was the cultivar 'Camarosa' because of its high fruit quality and later fruit ripening time in comparison with 'Alba' and 'Viktoriana' cultivars. The studies were carried out to recommend the use of mulching for this species.

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