

Influence of Mulch Type and Fertilization System upon the Percentage of Fruits Set and Yield in Strawberry

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Abstract. In recent years, organic strawberry culture is becoming more and more important but knowledge concerning best practice is still contradictory. Behavior of ten strawberry cultivars - 'Alba', 'Kimberly', 'Korona', 'Elliany', 'Elsanta', 'VimaZanta', 'Viktoriana', 'Virena', 'VimaXima', 'Premial' under three different types of mulch (agro-textile, 0,04 mm thick black polyethylene and straw) and two fertilizer systems (poultry manure and liquid NPK 24:8:16, Mg 2.2%, S 2%, B 0.03%, Fe 0.1%, Mn 0.05% and Zn 0.025%) has been studied in climatic conditions from Cluj-Napoca, Romania in 2012. The control cultivar was 'Premial'. Observations were made on number of trusses, number of flowers, percent of fruits set, and yield at end of first growing season. There were varieties scattered compact trusses, with flowers arranged at or above the leaves. In the trusses, each flower is solitary or terminal and opens upward. The flowers are large, medium or small depending on the species and their position on the plant. The size of the fruit is related to the rank of the flower from which the fruit developed. The best behavior in the experimental conditions proved 'Viktoriana' and 'VimaXima' because of their high productivity. It was noted that organic fertilization has a high influence on number of inflorescence 'VimaXima' and 'Virena' and the percentage of fruits set.

Keywords: cultivar, mulch system, poultry manure, strawberry, trusses, yields

INTRODUCTION

It is proved that from the "*Rosaceae*" family, the strawberry (*Fragaria ananassa Duch.*) is the most delicious and refreshing fruit. It is characterized by specific flavor and high content of vitamins and minerals (Sharma, 2002). Mature strawberries are high in water (90%), total soluble substances (10%) and many dietary components (Jin *et al.*, 2011).

Following numerous studies in determining the volatile components of the strawberry (Goff and Klee, 2006) it was found that strawberry flavor is given by 350 volatile substances (Pineli *et al.*, 2011).

Depending on the start of bloom and bloom period, the strawberry varieties can be grouped into: June bearing, ever-bearing and day neutral strawberry (Strik and Finn, 2008).

Generally, due that strawberry are highly perishable fruits, is necessary to use mulch (Riffat *et al.*, 2011) both for keeping under control weeds and for obtaining clean fruits. In recent years, concern about prevention of environmental pollution and food safety has increased.

Organic mulch (straw, sawdust, plant debris) does not offer guaranteed protection against weeds every time, on the contrary, straw soil is contaminated with weed seeds and it temporarily diminishes soil nitrogen decomposition (Kasirajan and Mathieu, 2012).

It is known that straw mulch keeps a much lower temperature at ground level (Subrahmaniyan and Zhou, 2008) in comparison with polyethylene mulch (Waterer, 2010). Temperature differences registered in mulching with different color polyethylene (colorless, gray, green, white, red) are insignificant (Lamont, 2004).

Meanwhile, early bloom and strawberry production were favored by black foil mulch (Singh *et al.*, 2007). Strawberries that ripened over red plastic mulch were significantly higher in aroma and flavor compounds (Loughrin and Kasperbauer, 2002).

The aim of the studies was to assess the percentage of fruits set and yield in the first season of vegetation under the climatic condition of Cluj-Napoca, Romania.

MATERIALS AND METHODS

The research has been carried out in a commercial farm, set up in spring of 2012 at Cluj-Napoca, Romania, and the Biological material was provided by Vissers Company, Netherlands and The Institute of Research and Development, Pitești Mărăcineni, in the form of strawberry runners.

The experimental design was a complete poly-factorial Latin rectangle design. First experimental factor was the cultivar having 10 graduations ('Alba', 'Kimberly', 'Korona', 'Elliany', 'Elsanta', 'VimaZanta', 'Viktoriana', 'Virena', 'VimaXima', 'Premial'). Strawberry were planted in single rows and beds covered with three different types of mulch (agro-textile, 0,04 mm thick black polyethylene and straw) so the second experimental factor having three graduation was type of mulch and the third factor was fertilization treatments (poultry manure and liquid NPK 24:8:16, also containing microelements Mg 2.2%, S 2%, B 0.03%, Fe 0.1%, Mn 0.05% and Zn 0.025%). The planting system chosen for the experimental plot was 40 cm between rows and 33 cm between plants within row.

The beds were raised 25 cm from soil level with drip irrigation lines under de mulch. In order to correspond to such a poly-factorial model, there were formed 60 variants, in three replication. Observation were made on number of inflorescences, the percentage of fruits set and yield in the first season of vegetation.

It is important to mention that all the observations were taken on „60 days” after planting the strawberry runners.

The results obtained were processed by means of the variant analysis the poly-factorial model of the divided plots. To analyze the data, the multiple comparison test of Duncan was used.

RESULTS AND DISCUSSIONS

Analyzing data from Tab. 1 can be observed that the highest percent of fruits set on agro - textile mulch were obtained. Regardless the cultivar the biggest average percent of fruits set was registered on agro-textile mulch (38.28%), followed by polyethylene mulch with (37.91%). The lowest percent of fruits set was registered on straw mulch with (36.89%). Differences between the three systems of mulch are statistically equal.

Data from the last column of the table show that regardless the type of mulch between the cultivars there are differences statistically assured regarding the percent of fruits set. Cultivar 'VimaXima' registered the highest results in percent of fruits set (53.83%), followed by 'Viktoriana' (48.28%) and 'Virena' (45.92%).

Data inside the table shows the combined influence of two experimental factors. The highest percent of fruits set were obtained by cultivar 'VimaXima' on agro-textile mulch and the lowest percent cultivar 'Alba' on straw mulch.

Tab.1

The influence of type of mulch and cultivar on the percent of fruits set in strawberry, [%]

Cultivars	Mulch system			Mean cultivar
	Agro-textile	Polyethylene	Straw	
‘Alba’	29.80 a-c	29.35 a-c	26.74 a	30.26 A
‘Premial’	28.01 a	34.76 a-f	29.89 a-d	31.81 A-B
‘Kimberly’	33.31 a-f	36.28 a-g	38.71 a-g	36.89 A-D
‘Korona’	30.78 a-e	36.04 a-g	34.10 a-f	34.09 A-C
‘Elianny’	41.48 b-g	40.32 b-g	40.87 b-g	39.70 B-E
‘Elsanta’	37.02 a-g	39.40 a-g	35.87 a-g	38.27 B-E
‘VimaZanta’	30.63 a-e	39.10 a-g	35.15 a-g	35.01 A-C
‘Viktoriana’	48.28 g-h	42.48 c-h	46.54 f-h	46.12 A
‘Virena’	45.92 f-h	41.48 c-h	37.90 a-g	40.03 C-E
‘VimaXima’	53.83 h	46.54 f-h	43.13 d-h	44.70 D-E
Mean mulch system	38.28 M	37.91 M	36.89 M	
LSD5% cvs. 7.16 – 8.24	LSD5% mulch system 3.45 – 3.66	LSD5% interaction mulch system x cultivar 10.91 – 13.28		

Note * = the difference between any two values followed by at least one common letter is not significant

Fertilization system had also a strong influence upon the percent of fruits set (Tab. 2). The differences between the two systems of fertilizer are statistically assured. The highest percentage of fruits set on poultry manure fertilizer (38.56%) was recorded followed by chemical fertilizer who registered (36.81%).

Tab. 2

Influence of fertilizer system and cultivar upon the percent of fruits set in strawberry, [%]

Cultivars	Fertilization system		Mean cultivar
	Poultry manure	NPK	
‘Alba’	28.49 a	28.40 a	28.45 A-C
‘Premial’	32.13 a-b	31.36 a-b	31.75 E
‘Kimberly’	35.67 a-d	38.11 a-e	36.89 B-E
‘Korona’	33.52 a-c	34.36 a-d	33.94 C-E
‘Elianny’	41.29 b-f	39.69 b-f	40.49 A-D
‘Elsanta’	40.09 b-f	36.46 a-d	38.28 B-E
‘VimaZanta’	32.37 a-b	35.90 a-d	34.14 D-E
‘Viktoriana’	49.98 f	44.31 d-f	47.15 A-C
‘Virena’	44.16 c-f	39.41 b-e	41.79 A-B
‘VimaXima’	47.94 e-f	40.25 b-f	44.10 B
Mean fertilization system	38.56 O	36.81 P	
LSD5% cvs 7.16 – 8.24	LSD5% fertilizer system 2.83		LSD5% interaction fertilization system x cultivar 8.95 – 10.98

Note * = the difference between any two values followed by at least one common letter is not significant

Data within last column of the table showed that ‘Kimberly’ and ‘Elsanta’ had similarly percent of fruits set, without differences statistically assured. The lowest percent of fruits set by cultivar ‘Alba’ were recorded. Regarding the combined influence of two experimental factors it can be observed that the highest percent of fruits set by cultivar ‘Viktoriana’ were obtained followed by ‘VimaXima’ on poultry manure fertilizer and the lowest percent cultivar ‘Alba’ on straw.

The highest number of inflorescence of cultivar ‘VimaXima’ on organic fertilizer it is also confirmed by Kahu *et al.*, (2010).

Tab. 3

Influence between mulch system and fertilization system upon the percent of fertile flower

Mulch system	Fertilization system		
	Poultry manure	NPK	Mean mulch
Agrotexsil	40.00 a	35.81 a	37.91 A
Polyethylene	38.23 a	38.32 a	38.28 A
Straw	37.47 a	37.47 a	36.89 A
Mean fertilization system	38.56 O	36.81 O	
LSD5% mulch system 3.45 – 3.66	LSD5% fertilizer system 2.83		LSD5% interaction fertilization system x mulch 4.90 – 5.55

Note * = the difference between any two values followed by at least one common letter is not significant

Table 3 introduces data regarding the interactions between fertilization system and mulch type in strawberry culture. There were no statistically differences between the interaction of mulch system and fertilizer system. The greatest influence on the percentage of fruits set has the cultivar ($F=4.604$), followed by interaction between cultivar x fertilizer system ($F=2.073$). The slightest influence on percent of fruits set has the mulch system ($F=0.354$) followed by interaction between mulch system x fertilizer system ($F=0.805$).

Total yield in the first growing season is critical for plant vigor level and provide income from early fruit sales (Tab.4).

In all mulching systems there were differences between yields statistically assured. Regarding the precocity of the cultivars, one can say that agro-textile and straw mulch gave the best results. In the straw mulch system the average yield was 7.12 t/ha followed closely by agro-textile mulch with 7.10 t/ha. Between cultivars were also differences statistically assured. The biggest average yield by the cultivar ‘Viktoriana’ was registered followed closely by ‘VimaXima’ and ‘Virena’. The lowest productive were the cultivars ‘Alba’, ‘Premial’, and ‘Korona’. The high productivity of the ‘Vima Xima’ cultivar was also reported by other authors such as Masny and Żurawicz (2010).

Tab. 4

Influence of mulch system and cultivar upon average yield (t/ha) at end of first growing season

Cultivars	Mulch system			
	Agrotexsil	Polyethylene	Straw	Mean cultivar
‘Alba’	1.97 ab	1.41 a	2.23 bc	1.87 A
‘Premial’	1.70 ab	2.94 de	2.72 cd	2.45 B
‘Kimberly’	8.21 h	5.88 f	10.00 k	3.09 C
‘Korona’	2.80 de	3.18 de	3.29 de	3.15 C
‘Elianny’	8.45 hi	9.12 j	11.85 m	8.03 D
‘Elsanta’	8.08 gh	7.60 g	8.93 ij	8.20 D
‘Vima Zanta’	2.78 de	3.30 de	3.38 e	9.81 E
‘Viktoriana’	12.25 mn	12.76 n	21.93 p	15.65 F
‘Virena’	12.02 m	11.32 l	9.75 k	11.03 G
‘Vima Xima’	12.76 n	13.74 o	13.60 o	13.37 H
Mean mulch system	7.10 M	8.77 N	7.12 M	
LSD5% cvs 0.34 – 0.39	LSD5% mulch system 0.16 – 0.17		LSD5% interaction mulch system x cultivar 0.52 – 0.63	

Note * = the difference between any two values followed by at least one common letter is not significant

Comparing the two fertilization systems there are significant differences, statistically assured regarding average yield (Tab. 5). The highest average yield on poultry manure fertilizer was registered, 7.99 t/ha, followed by chemical fertilizer with 7.35 t/ha. Data within last column of the table shows that ‘Elianny’ and ‘Elsanta’ had similarly yield, without differences statistically assured. Cultivar ‘Alba’ registered the lowest average yield. Regarding to the combined influence of two experimental factors the biggest yield by cultivar ‘Viktoriana’ on poultry manure was obtained and the lowest average yield was registered by cultivar ‘Alba’ on straw mulch.

Tab. 5

Influence of fertilization system and cultivar upon average yield (t/ha) at end of first growing season

Cultivars	Fertilization system		
	Poultry manure	NPK	Mean cultivar
‘Alba’	1.75 a	1.99 a	1.87 A
‘Premial’	2.66 bc	2.24 ab	2.45 B
‘Kimberly’	8.28 f	7.78 e	3.09 C
‘Korona’	3.14 cd	3.04 cd	3.15 C
‘Elianny’	9.99 h	9.63 h	8.03 D
‘Elsanta’	8.88 g	7.53 e	8.20 D
‘Vima Zanta’	3.00 cd	3.31 d	9.81 E
‘Viktoriana’	16.95 n	14.35 m	15.65 F
‘Virena’	11.58 j	10.48 i	11.03 G
‘Vima Xima’	13.36 l	13.10 k	13.37 H
Mean fertilization system	7.99 O	7.35 P	
LSD5% cvs 0.34 – 0.39	LSD5% mulch system 0.15	LSD5% interaction fertilization system x cultivar 0,46 – 0,57	

Note * = the difference between any two values followed by at least one common letter is not significant

In Tab. 6 it is showed the influence between mulch system and fertilization system upon the average yield. The differences are statistically assured. Data within the table show that the biggest yield in straw mulch and poultry manure was registered.

Tab. 6

Influence between mulch system and fertilization system upon the average yield (t/ha) at the end of first season

Mulch system	Fertilization system		
	Poultry manure	NPK	Mean mulch
Agro-textile	7.53 c	6.67 a	7.10 M
Polyethylene	7.10 b	7.15 b	8.77 N
Straw	9.32 e	8.21 d	7.12 M
Mean fertilization system	7.99 O	7.35 P	
LSD5% mulch system 0.16 – 0.17	LSD5% fertilizer system 0.15		LSD5% interaction fertilization system x mulch 0.25 – 0.29

Note * = the difference between any two values followed by at least one common letter is not significant

The greatest influence on the average yield has the cultivar (F=1859.687), followed by mulch system (F=274.363). The slightest influence on average yield has the interaction between cultivar x fertilizer system (F=13.752) followed by interaction between mulch system x fertilizer system (F=23.339).

CONCLUSIONS

The experiment revealed that among the evaluated cultivars the most useful for cultivation in Transylvania was the cultivar 'Viktoriana' and 'VimaXima' because of their high productivity, high fruit quality and later fruit ripening time in comparison with other cultivars.

In terms of the level of productivity this cultivar is not inferior to the control cultivar 'Premial' and produces larger and firmer fruits; moreover plants of this cultivars has a high resistance to disease.

The current study indicated that strawberry is a suitable and perspective crop for organic cultivation.

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