Bulletin UASVM Horticulture, 70(1)/2013, 187-194
Print ISSN 1843-5254; Electronic ISSN 1843-5394

Indicators of Economic Efficiency on Strawberry Yield Under the Influence of Three Different Mulches and Two Fertilizers

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Abstract. One of the most important characteristics of modern strawberry cultivars is fruit size, whitch is estimated in the course of selection on the basis of the single fruit weight. The profitability of crops depends on the level and quality of production, the possibility of capitalization, but also on production costs, which should be as low as possible. The present study aims to analyze the economic efficiency in case of strawberry culture experiments performed with different culture technologies: ten cultivars, three different mulches and two fertilizers. Indicators of economic efficiency (unit cost of production, unit gross profit, profit rate, labor productivity, production costs on equivalent product) were calculated for each variant separately. Biological material was ten genotipes of strawberry, gruped in three maturing varieties [(early maturing:'Alba', 'Premial'), medium maturing varieties ('Kimberly', 'Korona', 'Elsanta', 'Vima Zanta') and late maturing varieties ('Elliany', 'Viktoriana' 'Virena', 'Vima Xima')], in the form of strawberry runners. The second experimental factor having three graduation was type of mulch (agro-textile, 0,04 mm thick black polyethylene and straw) and the third experimental factor fertilizer systems [poultry manure and chemical fertilizer (NPK complex 28:8:16 ratio)] . The research is based on a comparative analysis of revenue and expenditure per hectare of cultivation and the production results obtained in comparative experiments. Late maturing cultivars, being a productive variety, which during all experimental years registered the highest production, is ranked first in terms of profit. The selling price level influeces the achievement of a high uniform profit, also influenced by the adjustment mechanism of market supply and demand, depending on the seasonality of production.

Keywords: economic indicators, efficiency, mulch system, profit, strawberry.

INTRODUCTION

The expansion of strawberry culture in the world for its considerable gross value of production and nutrient value has drawn the attention of most growers (Narges *et al*. 2011a). Currently, United State of America, Spain, Turkey, Russian Federation and Republic of Korea are the main strawberry producer countries (FAO, 2007).

Growers can use various methods of "forced cultivation" in open field, solarium and greenhouses to produce off-season strawberry to take advantage of high market prices during winter and spring months (Anonymous, 1995).

Strawberry is produced both on open field and under cover in greenhouse. There are two main cultivation technologies of strawberry in Romania: plastic and straw mulch. Until now there are no data confirm strawberry on agro-textile mulch. Therefore, a better understanding of the influence of mulch on weed control and crop yield response is necessary.

Weeds compete with strawberry for sunlight, nutrients, and moisture. The opacity of plastic mulch influences weed control. Black plastic mulch controls weeds because weeds cannot grow in the absence of photosynthetically active light (Olson, 2002). However a yield loss of up to 15% can be expected with a substitution of black plastic for straw in reducing late – spring frost damages.

The agro-textile mulch in strawberry business is very capital intensive with the basic material erected depending on major options. Choosing the best treatment program for a strawberry culture is required for providing economical and effective results. In strawberry production, management practices can be defined as a set of alternative production techniques such as materials, nutrient system, labors, mechanical work, cultivating programs etc.

Several researches have focused on determining efficiency in agricultural units and various products ranging from cultivation and horticulture to aquaculture (Iraizoz *et al*., 2003; Singh *et al*., 2004).

Developing strategies for fruits production must be based on comparative analysis, studies which producers to decide on the comparative advantages. The outcome in fruits production process depends not only on the volume and quality of products obtained, but in a high measure of the market.

The yield is considered marketable if classified into Extra and Class I, Class II berries according to EC Commission Regulation No 843/2002, with a minimum equatorial diameter of 25 an 18 mm, respectively, or unmarketable, if showing defect size, soundness or shape.

Tab. 1

Strawberry – Average retail price per kg, 2013

Marketable classified	Average retail price/$
Extra	3,6
Category I	2,7
Category II	1,5

Selling price of fresh strawberry is highly variable depending on the following factors: seasonality of production, variation in the supply, quality expressed by physical characteristics (shape, color, size, uniformity) and the state of integrity, tenderness and health, the cost price of the product (Balcău *et al*., 2013).

The objective of the present study was to analize and compare the economic efficiency in strawberry yield under the influnce of several mulch types (agro-textile, black polyethylene and straw vetch) and two fertilizers.

MATERIALS AND METHODS

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

Tab.2

Strawberry – ripening age
(Scholtz *et al*., 2008)

Ripening age	Varieties	Maturity time overview
Early maturing	Alba, Premial	18 May – 17 June
Medium maturing	Kimberly, Elsanta, Korona,Vima Zanta	27 May – 28 June
Late maturing	Elianny, Viktoriana, Virena, Vima Xima	14 June – 10 July

From the analysis of fruit ripening age, old and new varieties of strawberries were classified as: early maturing varieties, varieties with medium maturing and late maturing varieties. First experimental factor was the cultivar having three graduations (Tab. 2).

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. The experimental design was a complete polifactorial Latin rectangle design. In order to correspond to such a polifactorial model, there were formed eighteen variants (Tab. 3), in three replication.

Tab. 3

Experimental variants

Variant symbol	Factor A – maturing varieties	Factor B - mulch	Factor C – the fertilizer
V1	Early maturing	Agro-textile	Chemical
V2	Early maturing	Agro-textile	Poultry manure
V3	Early maturing	Black polyethylene	Chemical
V4	Early maturing	Black polyethylene	Poultry manure
V5	Early maturing	Straw	Chemical
V6	Early maturing	Straw	Poultry manure
V7	Medium maturing	Agro-textile	Chemical
V8	Medium maturing	Agro-textile	Poultry manure
V9	Medium maturing	Black polyethylene	Chemical
V10	Medium maturing	Black polyethylene	Poultry manure
V11	Medium maturing	Straw	Chemical
V12	Medium maturing	Straw	Poultry manure
V13	Late maturing	Agro-textile	Chemical
V14	Late maturing	Agro-textile	Poultry manure
V15	Late maturing	Black polyethylene	Chemical
V16	Late maturing	Black polyethylene	Poultry manure
V17	Late maturing	Straw	Chemical
V18	Late maturing	Straw	Poultry manure

The poultry manure was applied after being diluted with water in a ratio of 1:10 end left to soak for 7 days. After tillage two multi-phase fertilizations were slow release by fert-irigation at the rate of 300 kg/ha (organic fertilizer) and 1,2 t/ha (chemical fertilizer) , at an interval of two weeks.

Marketable fruit yeild was collected twise per week for a total of eight harvests in 2013 season. Production systems and cultivars affected early and total yields for strawberries.

To calculate economic efficiency of the culture, a sheet is drawn where all the technological production costs are found. These constitute the basis of the calculation of the following economic indicators: unit cost, unit profit, profit rate, labor productivity and production costs.

RESULTS AND DISCUSSIONS

Correct determination of production costs requires assessing each item of expenditure, which are highlighted in the strawberry technological culture sheet in semi-mechanized crop.

In the first part of the sheet the necessary material costs to establish culture are shown and in the second part can be found the labor costs (Tab. 4). These data are needed for the calculation of tracked economic indicators.

Tab. 4

Technological sheet after which economic indicators were calculated

Nr.	Items of expenditure	lei/ha	%
	Material expenses		
1.	Materials from its own sources	0	-
2.	Purchased materials	7600	26,48
3.	Supply costs (10%)	760	2,65
4.	Mechanical work expenses	940	3,28
5.	Value of water for irrigation	5000	17,42
6.	Amortization of fixed assets	0	0,00
7.	Tax on agricultural income	0	0,00
8.	Other material expenses (1%)	143	0,50
	TOTAL material costs	14443	50,33
Nr. ctr	Labour expenses	lei	%
1.	Manual work expenses	9954	34,69
2.	Contributions to social insurance (20,8%)	2070	7,21
3.	Contributions to Health Insurance (5,2%)	518	1,80
4.	Contributions to the unemployment fund (0,5%)	50	0,17
5.	Contributions to the risk and accidents fund (0,205%)	20	0,07
6.	Unique National Fund (0,85%)	85	0,29
	TOTAL labour expenses	12129	42,27
	TOTAL direct expenses (I + II)	26572	92,59
	Indirect costs (8%)	2126	7,41
	TOTAL production expense (CT)	28698	100,00
	The value of secondary production (VPS)	0	0,00
	Main production expenses	28698	100,00

(Source: Pocol, 2009) proccessing own results

Gross returns include revenues from strawberry production only. Imputs are including labor, capital, fertilizer espences and all other expences per hectare in year 2013. Capital includes interest costs (short and long term debt), depreciation, maintenance, insurance and other annual expences of fixed assets (irrigation, mulch system and machinery equipments). Labor includes family and hired labor an is measured in hours. Fertilizer expences represent the annual quantity for plant nutrition and measured in kilogram; while other expences are the summation of all trifle other variable costs (water for irrigation, chemicals, transportation, electricity, taxes etc.).

The data analysis was carried aut with the help of the Excel 2007 spreadsheet, SPPSS 16.0 software.

Previously presented data in the technology sheet (Tab. 4) are specific for variant early maturing x agro-textile x chemically fertilized. For other variants the total costs are

shown, both in terms of labor and materials but also in indirect costs in (Tab. 5). It should be noted that the use of two different mature variants did not involve additional costs. This study is based on comparative analysis of revenue and expenditure for a hectare of crop and results obtained in the experimental variants production.

Tab. 5

Total costs of production for each experimental variant

Variant	Total production (t/ha)	Production costs (lei/ha)			
		Materials	Labour	Total direct	Overall
V6	8,53 a	68 379	23 315	91 694	99 029
V5	9,62 b	94 430	21 955	116 385	125 696
V3	11,03 c	99 516	15 629	115 145	124 357
V1	11,46 d	107 883	11 993	119 876	129 466
V4	11,75 e	81 614	16 051	97 665	105 478
V2	12,62 f	88 536	15 469	104 006	112 326
V12	13,06 g	72 518	23 505	96 022	103 704
V11	14,28 h	94 535	13 035	107 570	116 175
V17	14,75 i	90 447	25 756	116 203	125 499
V7	15,27 j	107 792	17 927	125 719	135 777
V13	17,06 k	107 705	18 282	126 074	136 160
V15	17,24 l	98 038	18 293	116 331	125 637
V18	18,62 m	73 338	26 566	99 904	107 896
V9	19,37 n	98 038	22 492	120 530	130 172
V16	21,06 o	80 176	22 576	102 752	110 973
V10	21,09 o	80 183	22 425	102 608	110 817
V8	23,37 p	88 536	22 650	111 187	120 082
V14	23,61 q	88 530	22 777	111 314	120 219

LSD5% cvs 0,18 – 0,21

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

Analyzing data on total obtained production which were statistically analyzed using Duncan analysis can be seen that regardless the type of mulch and fertilizer there are differences statistically assured. The highest value was registered by variant (late maturing varieties, straw – vetch mulched, organically fertilized) 23.61 t/ha and the lowest production value was registered by variant (early maturing varieties, straw – vetch mulched, organically fertilized) 8.53 t/ha. Total cost of production include four section of materials, labor, capital (fixed cost) and other costs (water, diesel, electricity etc.), share of each section can be seen in (Tab. 5). A summary of main economical indicators are give in (Tab. 6). The total expenditure ranged between 99 029 lei/ha and 120 219 lei/ha; and the gross production value ranged between 102 360 lei/ha and 212 490 lei/ha. Based on these results, the BC ration from strawberry production in this experiment was calculated range between 1.03 and 1.76.

BC ratio = gross value of production/production cost (Ozkan *et al*., 2004)

The research results were consistent with finding report by other authors, such as: 1.74 for strawberry (Banaeian *et al*., 2011), 2.37 for orange, 1.89 for lemon and 1.88 for mandarin (Ozkan *et al*., 2004), 2.53 for sweet cherry (Demircan *et al*., 2005), 2.58 for cucumber (Mohammadi *et al*., 2010), 1.03 for stake – tomato (Esengun *et al*., 2007), 0.86 for cotton (Yilmaz *et al*., 2005), 1.17 for sugar beet (Erdal *et al*., 2007) and 2.13 and 2.14 for apricot (Gundogmus, 2006) under the organic and conventional farming systems, respectively.

Tab. 6

Economic efficiency factors of strawberry crop based on experimental variants

Variant	Production		Purchased price (lei/kg)	Variable costs		Profit	
	Physis (t/ha)	Global thousand (lei/ha)		Total (lei/ha)	Units (lei/ha)	Total (lei/ha)	Unitar (lei/kg)
V6	8,53 a	8,50	12	99 029	11,61	710	0,39
V5	9,62 b	9,22	12	125 696	13,07	588	- 1,07
V3	11,03 c	10,97	12	124 357	11,27	951	0,73
V1	11,46 d	11,00	12	129 466	11,29	906	0,71
V4	11,75 e	11,15	12	105 478	8,98	1176	3,02
V2	12,62 f	12,07	12	112 326	8,90	1291	3,10
V12	13,06 g	13,00	9	103 704	7,94	1575	1,06
V11	14,28 h	14,18	9	116 175	8,14	1675	0,86
V17	14,75 i	14,20	5	125 499	8,51	1696	0,49
V7	15,27 j	15,17	9	135 777	8,89	1677	0,11
V13	17,06 k	16,95	5	136 160	7,98	2029	1,02
V15	17,24 l	17,04	5	125 637	7,29	2152	1,71
V18	18,62 m	18,32	5	107 896	5,79	2586	3,21
V9	19,37 n	19,31	9	130 172	6,72	2561	2,28
V16	21,06 o	21,00	5	110 973	5,27	3091	3,73
V10	21,09 o	21,00	9	110 817	5,25	3092	3,75
V8	23,37 p	23,17	9	120 082	5,14	3434	3,86
V14	23,61 q	23,21	5	120 219	5,09	3440	3,91

The results of this study indicate that although strawberry production is a high energy consumer but it is a profitable agricultural operation and net return ranged between 710 lei/ha and 3440 lei/ha in year of 2013. Productivity expressed by lei/kg that means each lei expending in strawberry production how much product is produced. In this study productivity ranged between -1.07 lei/kg and 3.91 lei/kg.

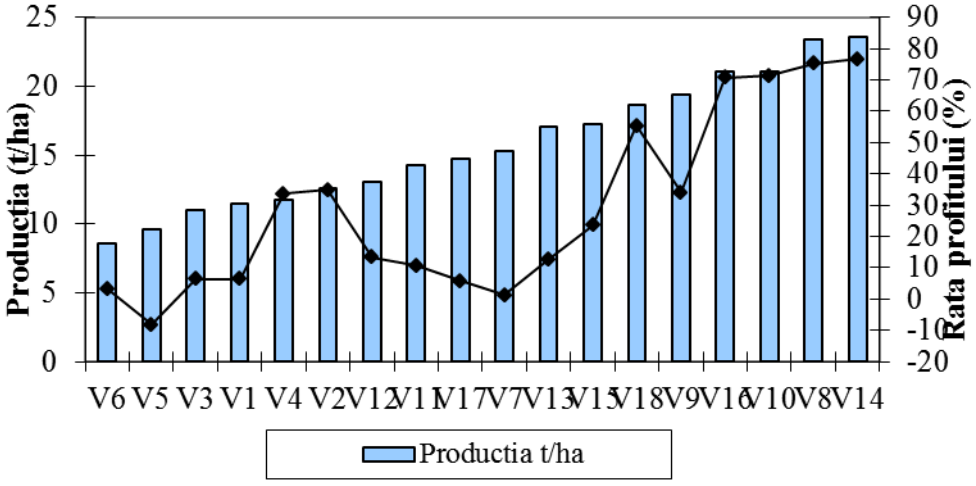

Fig. 1. Profit rate recorded by each variant

Profit rate is shown in Fig. 1. From this graph it can be observed that the profit rate recorded the highest values for chemically fertilized variant, medium maturing varieties and straw mulched 50.10% followed by variant fertilized the same and with straw mulch but early

maturing varieties 46.26%. The lowest profit rate was registered by the variant mulched on black polyethylene, chemical fertilized and medium maturing varieties 17.20%.

CONCLUSION

Analyzing the results regarding economic efficiency on etrawberry yield under the influence of three different mulches and two fertilizers it cand be drawn the following conclusions:

1. From the interaction of maturing stages cultivars and fertilizer, the highest production was registered by the variant late maturing cultivars (ʻAlba', 'Premial') on agro-textile mulch 20,33 t/ha and the lowest production was registered by the variant early maturing(('Elliany' 'Viktoriana' 'Virena', 'Vima Xima') mulched with straw 9,07 t/ha.
2. Fertilization system had also a strong influence upon the total yeild. Variant early maturing, fertilized chemical realized the lowest yeild 10,70 t/ha and late maturing varieties fertilized organically realized the highest yield 21,10 t/ha.
3. From the combing of all three factors variant mulched on agro-textile, fertilized organically and late maturing achieved the highest yield 23,61 t/ha.
4. BC ration from strawberry production in this experiment was calculated range between 1.03 and 1.76.
5. Strawberry production is a high energy consumer but it is a profitable agricultural operation and net return ranged between 710 lei/ha and 3440 lei/ha in year of 2013.
6. Highest profit was recorded for variant V11, in which the medium maturing varieties was chemically fertilized and straw mulched, it has a value of 50,10% and the lowest rate of return 17,20% was recorded by variant mulched on black polyethylene, chemical fertilized and medium maturing varieties .

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