

# RESEARCH REGARDING SOIL MAINTENANCE METHODS IN APPLE TREE CULTIVATION IN THE CÂRCINOV-ARGES FRUIT GROWING BASIN

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## Abstract

*In the last decade, the introduction of genetically resistant varieties and the reduction of phytosanitary treatments the led to lower production costs, less chemically polluted fruits, making from apple tree cultivation a profitable culture in the consecrated countries.*

*Keywords: Florina apple variety, Generos apple varieties, soil tillage, soil mulch*

## 1. INTRODUCTION

Currently applied technologies in apple tree culture ensure vast and stable crops with a good retention. Growers know the technological elements that lead to tree vigor reduction, early fructification, load rate tree standardization, foliar fertilization, watering systems, rules and techniques of cutting and integrated control of pests and diseases, hail crops protection.

In the last decade, the introduction of genetically resistant varieties and the reduction of phytosanitary treatments the led to lower production costs, less chemically polluted fruits, making from apple tree cultivation a profitable culture in the consecrated countries (Germany, Switzerland, Italy, France).

In practice, due to farmers' limited financial opportunities, these research achievements can be sporadically found. Fruit harvesting is designated in a small proportion for processing and trade and at a higher quality standards as there aren't applied all the recommended agro links.

## 2. MATERIAL AND METHOD

There were taken in study trees of 5 and 11 years old, for Florina and Generos apple tree varieties, grafted on MM 106 and 5 different types of soil maintenance.

### *Variety and variant*

#### *Generos Variety/MM106*

V1 - (Mt) - worked field,

V2 - fallowed on the interval, hand soil tillage on the trees row,

V3 - fallowed on the interval and herbicided on the trees row,

V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows,

V5 – fallowed on the interval and polyethylene film cover on the trees row.

#### *Florina Variety/MM 106*

V1 - (Mt) - worked field,

V2 - fallowed on the interval, hand soil tillage on the trees row,

V3 - fallowed on the interval and herbicided on the trees row,

V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows,

V5 – fallowed on the interval and polyethylene film cover on the trees row.

There were taken under observations elements of the vegetative growth of trees (trunk circumference and average length of annual increases in cm, and average weight of fruit production,

soil moisture at different depths and maintenance of soil types, changes in temperature at different times of day.

We calculated the significance of differences for growth elements and for the production at different versions which have been studied (table 1. A, B).

### 3. RESULTS AND DISCUSSIONS

Data obtained regarding trunk circumference showed that the 5-year-old trees at the Generos variety were ranged between 15.4 cm and 23.9 cm, with an augmentation of growth of 6.6 to 14.3 cm, which is influenced by the ground maintenance method, as it follows:

*Table 1. (A, B). Elements of vegetative growth for Generos and Florina varieties, grafted on MM 106, for different soil maintenance variants (Boțești 2008)*

A. Variety and variant	At 5 years				
	Trunk circumference				Average length of annual increases (cm)
	Cm	%	Diff. ± over Mt	Growth production (cm)	
<b>GENEROS/MM106</b>					
V1 - (Mt) - worked field	23,9	100	-	14,3	71,2
V2 - fallowed on the interval, hand soil tillage on the trees row	16,3	68	- 7,2 <sup>ooo</sup>	6,6	47,9
V3 - fallowed on the interval and herbicided on the trees row	17,5	73	- 6,4 <sup>ooo</sup>	7,4	40,7
V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows	21,5	90	-2,4 <sup>o</sup>	9,6	51,2
V5 – fallowed on the interval and polyethylene film cover on the trees row	15,4	64	- 8,5 <sup>ooo</sup>	6,8	50,8
<b>FLORINA/MM106</b>					
V1 - (Mt) - worked field	51,7	100	-	23,8	53,8
V2 - fallowed on the interval, hand soil tillage on the trees row	39,1	76	- 12,6 <sup>oo</sup> o	18,2	48,3
V3 - fallowed on the interval and herbicided on the trees row	45,1	87	-6,6 <sup>ooo</sup>	21,3	46,6
V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows	46,0	89	-5,7 <sup>ooo</sup>	21,4	43,6
V5 – fallowed on the interval and polyethylene film cover on the trees row	32,8	63	- 18,9 <sup>oo</sup> o	11,5	45,3

5 years old:

- Generos: DL 5%=1,97; DL 1%=2,87; DL 0,1%=4,31.
- Florina: DL 5%=0,99; DL 1%=1,44; DL 0,1%=2,17.

B. Variety and variant	At 11 years				
	Trunk circumference				Average length of annual increases (cm)
	Cm	%	Diff. ± over Mt	Growth production (cm)	
<b>GENEROS/MM106</b>					
V1 - (Mt) - worked field	31,9	100	-	2,5	46,8
V2 - fallowed on the interval, hand soil tillage on the trees row	33,5	105	+1,6*	2,2	46,4
V3 - fallowed on the interval and herbicided on the trees row	31,8	100	-0,1	2,1	40,5
V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows	31,6	99	-0,3	2,6	41,5
V5 – fallowed on the interval and polyethylene film cover on the trees row	33,1	104	+1,2	2,5	44,2
<b>FLORINA/MM 106</b>					
V1 - (Mt) - worked field	31,5	100	-	2,9	45,3
V2 - fallowed on the interval, hand soil tillage on the trees row	33,7	107	+2,2**	2,7	43,7
V3 - fallowed on the interval and herbicided on the trees row	36,6	116	+5,1***	2,8	44,7
V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows	34,9	111	+3,4***	3,0	43,3
V5 – fallowed on the interval and polyethylene film cover on the trees row	32,0	102	+0,5	2,8	39,0

11 years old:

- Generos: DL 5%=1,60; DL 1%=2,40; DL 0,1%=3,60.
- Florina: DL 5%=1,29; DL 1%=1,87; DL 0,1%=2,81.

Larger values of trunk circumference growth were recorded in variants V1 (worked field), V3 (the fallow period and sprayer row of trees) and V4 (the fallow period and soil mulch on the rows of trees, plant material results mowing of weeds on the interval between rows of trees).

The growth differences for the other variants are small. The influence of the technique of soil maintaining in the apple orchards is also maintained at Florina/MM 106 variety, at five years old, with higher annual growth rate registered at the same variants V1, V2 and V4. Data on trunk circumference, statistically calculated, confirm this aspect with significantly negative differences compared to the witness variant.

Concerning 11-year-old trees, trunk circumference at the Florina and Generous varieties grafted on rootstock MM 106, was ranged between 31.5 and 36.5 cm, with a growth increase of 2.1 and 3 cm higher values being recorded at the V4, mulch on the ground among the trees.

At both ages of the trees the best variant is 4 which, in prolonged drought, the grass mulch resulted from the delay between tree rows provided better water conservation in the roots, ensuring increased vegetative growth during periods of water stress. It is also noted that the increase of 5 years old trees growing, for both varieties, is higher compared to that of 11 years old trees,

regardless of variation of soil maintenance. Statistically calculated data confirmed significantly positive differences on the Florina apple tree variety in variants 3 and 4.

Production and average weight of fruit varieties grafted on MM106 Generous and Florina, obtained in 2008 and 2009, the maintenance of soil variants shown in (table 2.). The data presented indicates that the average fruit per variety Generos/MM106 fluctuated between 28.9 and 36.0 t / ha, being higher in version 4, the fallow period and soil mulch row of trees, plant material result of cutting the weeds on the interval between rows of trees.

The same point is also highlighted at Florina/MM106 variety where the fruit production was established between 30.3 and 35.3 t/ha, with average fruit weight between 148 and 153 g at the Generous variety and from 28,9 to 36.0 t/ha and average fruit weight between 156-163 g. The largest fruits were recorded for variant 4.

Productions at variants 4 overcome the witness of 9% both at the Generos and Florina variety, significantly positive differences positive being recorded at Generos and distinctly significantly positive differences at the Florina apple tree variety.

*Table 2. Production and average weight of Generos and Florina varieties, grafted on MM 106, for different soil maintenance variants (Voinești and Cărcinov, 2008)*

Variety and variant	Fruit production (t/ha)					Average fruit weight (g)
	2008	2009	Mean	%	Diff. ± over Mt (t/ha)	
<b>GENEROS/MM106</b>						
V1 - (Mt) - worked field	28,7	37,5	33,1	100	-	156
V2 - fallowed on the interval, hand soil tillage on the trees row	24,4	36,4	30,4	92	-2,7 <sup>oo</sup>	157
V3 - fallowed on the interval and herbicided on the trees row	17,7	40,1	28,9	87	-4,7 <sup>ooo</sup>	160
V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows	28,4	43,7	36,0	109	+2,9 <sup>***</sup>	163
V5 – fallowed on the interval and polyethylene film cover on the trees row	26,3	35,5	30,9	93	-2,2 <sup>oo</sup>	156
<b>FLORINA/MM 106</b>						
V1 - (Mt) - worked field	26,2	38,2	32,2	100	-	149
V2 - fallowed on the interval, hand soil tillage on the trees row	24,8	40,4	32,6	101	+0,4	149
V3 - fallowed on the interval and herbicided on the trees row	27,7	40,7	34,2	106	+2,0 <sup>*</sup>	148
V4 - fallowed on the interval and mulched on the trees row, with plant material resulted from weeds trimming on the interval between trees rows	25,4	45,3	35,3	109	+3,1 <sup>**</sup>	153
V5 – fallowed on the interval and polyethylene film cover on the trees row	24,0	36,7	30,3	94	-1,9 <sup>o</sup>	148

Generos: LD 5% = 1,32; LD 1% = 1,93; LD 0,1% = 2,89.

Florina: LD 5% = 1,58; LD 1% = 2,30; LD 0,1% = 3,45.

*Soil moisture determined at various depths and maintenance of soil moisture variations*

Soil moisture in August 2008, at 0-40 cm depth, had different values depending on the soil maintenance variant and depth, using the same variables as in table 2.

In table 3, there are presented two distinct aspects: humidity recorded for Florina variety parcel, after a dry period and the Generos variety, after a rain of 27.3 mm. On the interval 0-10 cm, the variant 4, humidity on the row of trees was 21.4% from 10.5 to 13.3 in the other variants.

After a 27.3 mm rain, soil moisture improved in the horizon of 0-10 cm, and moisture on the surface of polyethylene film on variant 5, where humidity was maintained to the same extent as before the rain, was between 11.1 to 12.1%.

**Table 3. Soil moisture determined at different depths and soil maintenance variants (Florina and Generos varieties – Voinești and Cărcinov 2008)**

Variant	Place	Soil humidity (%) at depth:				
		0	0-10 cm	11-20 cm	21-30 cm	31-40 cm
<b>FLORINA VARIETY – after a dry period</b>						
Variant 1	On the tree row	6,8	13,2	12,6	11,7	14,0
	On the interval	9,3	14,8	14,8	15,6	17,1
Variant 2	On the tree row	9,0	10,9	12,0	11,8	12,0
	On the interval	17,6	10,5	10,7	9,6	11,1
Variant 3	On the tree row	9,9	13,5	12,0	15,2	15,4
Variant 4	On the interval	19,2	21,4	17,8	17,2	18,0
	On the tree row	16,5	11,6	11,0	11,2	11,5
Variant 5	On the interval	11,1	13,3	13,1	13,1	12,8
<b>GENEROS VARIETY – after the rain (27,3 mm)</b>						
Variant 1	On the tree row	18,8	18,7	13,7	11,1	10,5
	On the interval	26,1	19,2	13,2	9,8	9,2
Variant 2	On the tree row	21,8	17,3	10,8	9,9	10,4
	On the interval	20,0	16,8	10,5	9,3	8,0
Variant 3	On the tree row	19,8	19,1	12,7	13,1	12,9
Variant 4	On the interval	21,8	18,9	15,4	11,4	10,0
	On the tree row	20,7	15,3	11,8	8,6	8,6
Variant 5	On the interval	11,1	12,1	12,3	12,5	12,0

In 2009, in a normal rainfall of 753.6 mm/year we find that the variant who maintained the highest humidity at soil surface and at the 0-40 cm depth was variant 4, followed on the interval and mulched soil on the row of trees, with plant material residues resulted from weed scything on the interval between tree rows (table 4.).

In variant 4, for August, the surface moisture was 13.8% compared to 7.8-9.6% in the other variants.

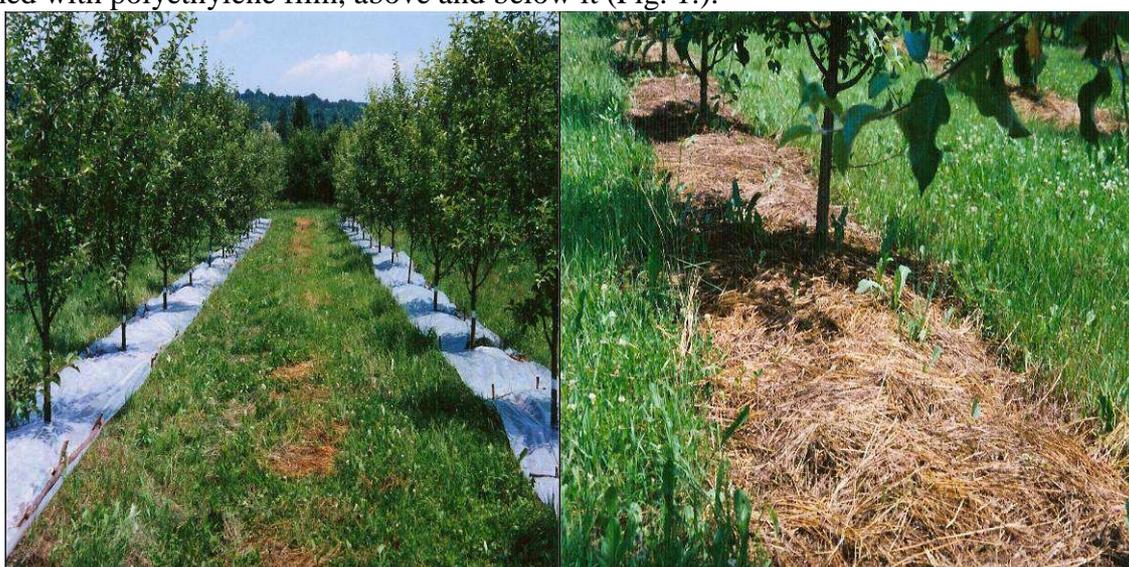
Also, a higher humidity at the surface is kept on uncultivated soil, but at a depth of 40 cm, the humidity is over 14%.

**Table 4. Soil moisture determined at different depths and soil maintenance variants (Florina and Generos varieties – Voinești and Cârcinov 2008)**

Variant	Place	Soil humidity (%) at depth:				
		0	0-10 cm	11-20 cm	21-30 cm	31-40 cm
<b>FLORINA VARIETY</b>						
Variant1	On the tree row	8,5	10,1	11,1	11,8	16,4
	On the interval	12,6	14,7	14,3	14,6	16,5
Variant 2	On the tree row	8,6	12,0	11,4	13,3	15,0
	On the interval	10,6	15,0	13,0	14,4	15,7
Variant 3	On the tree row	8,6	14,6	13,4	14,2	15,2
	On the interval	10,6	15,0	13,0	14,4	15,7
Variant 4	On the tree row	13,8	18,4	17,9	16,4	15,9
	On the interval	10,5	16,9	14,3	13,8	13,5
Variant 5	On the tree row	7,8	11,1	12,3	12,2	12,2
<b>GENEROS VARIETY</b>						
Variant 1	On the tree row	9,6	13,2	14,5	14,9	15,2
	On the interval	10,8	15,7	15,7	15,3	15,2
Variant 2	On the tree row	8,0	14,5	15,0	14,1	14,4
	On the interval	11,2	14,3	13,3	13,4	14,8
Variant 3	On the tree row	9,1	15,9	15,2	15,6	16,7
	On the interval	11,2	14,3	13,3	12,1	14,8
Variant 4	On the tree row	12,4	10,6	11,4	11,5	10,8
	On the interval	10,6	13,7	13,6	13,8	14,9
Variant 5	On the tree row	8,4	12,3	14,8	16,2	16,2

*Temperature at different times of day based on the variations of soil maintenance*

Within the 5 variants, temperature was recorded at 8.00, 13.00, 15.00 hours, differentiated in soil between the tree rows of trees with two variants (worked field and uncultivated field) and at soil on the tree row, in the following: herbicided, worked field, over the mulch and below the mulch, mulched with polyethylene film, above and below it (Fig. 1.).



**Figure 1. Mulched soil in the experimental variants at Voinești**

Soil mulching on the tree row with plant material resulted from the scythed weeds on the interval between tree rows has positive effects for temperature adjustment, especially during sunny, hot days.

Temperature recorded in July-August 2008 under mulch at 1.00 p.m. and 3.00 p.m. remained at 26.0° to 27.8° C (almost the same like 8.00, respectively 24.5 °C) in hot days, from 44.5° to 48 ,5° C at variants on the black field and worked among the trees (table 5.).

**Table 5. Temperature in different moments of the day depending on soil maintenance variants (Florina and Generos varieties – Voinești și Cârcinov 2008)**

*July – August*

Place	Temperature in cloudy days (°C)			Temperature in sunny days (°C)		
	8.00 a.m	1.00 p.m.	3.00 p.m.	8.00 a.m	1.00 p.m.	3.00 p.m.
In the shelter	15,0	23,0	22,3	23,0	32,0	33,0
In the air	15,4	22,0	26,4	23,8	32,0	33,5
At soil - worked field	19,0	27,6	27,2	25,5	42,0	44,5
Fallowed on the interval	15,0	22,5	24,6	22,3	28,5	30,6
Herbiced on the row	16,8	25,5	26,0	26,3	40,0	43,6
Worked on the row	17,5	26,5	28,0	26,9	46,0	48,5
Mulch on the row - over	16,6	25,2	26,0	28,1	43,0	43,6
- under the mulch	16,8	21,0	22,9	24,5	26,0	27,8
- over the polyethylene film	16,5	23,2	26,4	26,4	40,5	43,7
- under the polyethylene film	17,2	24,2	28,2	24,4	36,5	38,3

Data recorded in 2009, June, July and August confirm that the temperature under mulch at 1 p.m. and 3 p.m. maintains the levels like those from 8.a.m. (see tables 6 and 7), with a positive influence on preserving soil moisture.

**Table 6. Temperature in different moments of the day depending on soil maintenance variants (Florina and Generos varieties – Voinești and Cârcinov 2008)**

*June*

Place	Temperature in cloudy days (°C)			Temperature in sunny days (°C)		
	Ora 8	Ora 13	Ora 15	Ora 8	Ora 13	Ora 15
In the shelter	14,0	24,4	27,0	19,0	25,0	25,5
In the air	19,3	25,0	29,0	19,4	28,5	29,6
At soil - worked field	19,4	29,1	32,5	19,8	32,4	32,5
Fallowed on the interval	17,8	26,0	30,8	18,1	26,1	30,8
Herbiced on the row	16,4	26,8	30,0	17,2	30,3	31,6

Worked on the row	16,9	27,0	31,0	17,6	30,9	31,4
Mulch on the row - over	18,4	26,2	33,2	21,2	38,0	38,3
- under the mulch	18,4	23,0	27,7	19,3	26,8	27,7
- over the polyethylene film	20,5	33,0	28,2	23,0	36,8	38,0
- under the polyethylene film	21,0	40,0	33,0	25,2	49,0	50,5

**Table 7. Temperature in different moments of the day depending on soil maintenance variants (Florina and Generos varieties - Voinești 2008)**

*July – August*

Place	Temperature in cloudy days 8(°C)			Temperature in sunny days (°C)		
	8.00 a.m	1.00 p.m.	3.00 p.m	8.00 a.m.	13.00 p.m.	3.00 p.m
In the shelter	10,0	16,8	22,1	18,0	24,0	24,9
In the air	12,4	18,6	24,4	20,3	26,0	27,2
At soil - worked field	14,8	20,2	26,8	23,1	37,0	39,2
Fallowed on the interval	15,0	18,8	22,0	19,5	28,8	28,5
Herbicided on the row	14,0	0,0	27,0	21,6	39,5	41,0
Worked on the row	13,8	19,8	26,6	18,6	37,8	37,9
Mulch on the row - over	14,4	23,0	31,2	20,7	44,2	45,4
- under the mulch	16,8	18,4	20,4	18,8	24,5	24,8
- over the polyethylene film	14,4	25,2	29,8	28,0	38,6	39,8
- under the polyethylene film	17,8	21,4	22,6	25,5	30,5	31,4

#### 4. CONCLUSIONS

For the future, the undertaken research recommend the variant 4 which maintains a high humidity in the root area and a minimum temperature oscillation during dry periods, stops the weeds growth among the trees without herbicides interference and also facilitate an increased organic matter content in the soil, due to the decomposition of plant material resulted from cutting the weeds on the interval between rows of trees. This is the method that helps the ecological fighting against weeds that grow between trees or under their crown. Soil mulch at Florida variety is shown in the figures below.



*Figure 2. Soil mulch for Florina variety (23.06.2009, Boțești, original)*



*Figure 3. Soil mulch for Generos variety (2009, Botesti, original)*



*Figure 4. Soil mulch over soil surface (17.06.2009, Boțești - original)*



*Figure 5. Soil mulch on apple tree lines (23.06.2009, Boțești - original)*

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