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THE INFLUENCE OF ORGANIC FERTILIZATION ON GROWTH AND FRUITING OF SOME APPLE CULTIVARS IN MĂRĂCINENI-ARGEȘ AREA

Ștefan (Untaru) Roxana Ionela[1*], Botu Mihai[1,2], Mareși Eugenia[3]
[1]University of Craiova, Doctoral School of Engineering of Animal and Plant Resources Romania
[2]University of Craiova, Faculty of Horticulture, Department of Horticulture and Food Science, Romania
[3] Research Institute for Fruit Growing Pitești, Romania
**Corespondence author. E-mail*: roxanauntaru1@gmail.com

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ABSTRACT

Research was carried out in an apple field trial established in 2022 at Genetic and Breeding Department of RIFG Pitești-Mărăcineni, Romania. The following determinations were carried out: trees vigour (trunck diameter – mm; crown dimensions – cm; number and lenght of the annual shoots – cm) and yield (kg/tree). As results of the investigations we found that: the highest vigour was obtained at 'Aura' (45.50 mm) and 'Rubinola' (42.83 mm) cultivars in 3rd fertilization variant (Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha, foliar application); the best results regarding the fruits yield were also obtained in the 3rd fertilization variant (Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha, foliar application), among the cultivars being noted the 'Luna' cv. with an average fruit yield of 20.18 kg/tree and 'Rebra' cv. with 18.49 kg/tree.

INTRODUCTION

The largest cultivators of fruit trees in the ecological system are: China (116,000 ha), Italy (26,499 ha), USA (18,130 ha), France (23,450 ha), Turkey (20,244 ha), Poland (13,326 ha), Germany (8,400 ha), Spain (7,979 ha) and Romania (8,606 ha) (Butac et al., 2021; Willer et al., 2022, 2024).Of the fruit species, the most cultivated in the ecological system are: apple - 114,099 ha (36.98%), peach - 71.181 ha (23.07%), apricot - 37,920 ha (12.29%), plum - 19,562 ha (6.34%), sweet and sour cherry - 19.130 ha (6.20%), pear - 18,327 ha (5.94%), other species - 28,324 ha (9.18%) (Willer et al., 2022, 2024).The area cultivated with fruit trees in the ecological system, at the 2020 year level was 8,606 ha (2.2% of the ecological agricultural area), of which the apple occupies 3,296 ha (38.3% of the organic fruit area) (FiBl, 2022, 2024; Eurostat, 2024). In the last years, in the Romanian ecological fruit-growing sector was introduce new cultivars with scab resistance, good production and higher fruit quality such as 'Topaz', 'Red Topaz', 'Orion', 'Luna', 'Crimson Crisp', 'Dalinred', 'Ariwa' and 'Natyra' (Kienzle et al., 2016; Kienzle and Kelderer, 2017). This paper aims to evaluate the influence of organic fertilization on trees vigour and fruits yield at 12 apple cultivars with scab resistance, located in a field trial of RIFG Pitești, Romania.

MATERIALS AND METHODS

The experimental field was established in 2022 at RIFG Pitesti – Maracineni.Twelve apple cultivars grafted on 'M9' rootstock were planted in a spacing of 3.5 m between the rows and 1 m between trees, according to the following experimental scheme: Factor A – cultivar, with twelve graduation (a1 - 'Aura', a2 - 'Rumina', a3 - 'Jonaprim', a4 - 'Rustic', a5 - 'Rebra', a6 - 'Redix', a7 - 'Orion', a8 - 'Luna', a9 - 'Rubinola', a10 - 'Topaz', a11 - 'Goldrush', a12 - 'Crimson Crisp'); Factor B – fertilization variant, with three graduations (b1 – 'Unfertilized'; b2 - Biohumus – 0,7 l/tree, soil application; b3 – Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha, foliar application).

Biohumus is a 100% organic fertilizer, produced with the help of earthworms, which stimulates the yield, growth and health of trees. Biohumus was applied in two moments: in spring before the start of vegetation and in autumn after the fall of the leaves. Algacifo 3000 is a bioactivator which containing components of purely vegetal origin, derived by extracts of brown seaweed *Macrocystis integrifolia.* Algacifo 3000 was applied foliar in two moments: after flowering and in the young fruit phase.

The average multi-annual temperature was 10.1°C, the maximum temperature 38.8°C, whereas the minimum temperature –24.4°C; total annual rainfalls recorded was 673.2 mm. Compared to the baseline for 55 years period, the agricultural year, 2023-2024, was the hottest in the last 55 years, with 3.1 ºC over normal (13.2ºC compared to 10.1ºC as normal), following the multiannual climatic tendencies, but also much poorer in precipitation, with 193.2 mm (480.0 mm compared to 673.2 mm as it represents the normal interval October - September). In 2024, the following parameters were appreciated: trees vigour expressed by trunk diameter (mm), crown dimensions - height and diameter (cm), the number and length of the annual shoots (cm); yield in kg/tree.

The data were included in an Excel database and statistically analyzed using the SPSS 14.0 program, which uses the Duncan test (multiple t tests) at the 0.05 probability level.

RESULTS AND DISCUSSIONS

Regarding the trunk diameter (mm), measured with the digital callipers at 30 cm above the ground, it can be observed that, on average, on the 3 fertilization variants, the 'Aura' and 'Rubinola' cvs. registered the highest vigour (44.69 mm and 41.79 mm) significantly exceeding the 'Jonaprim' cv. (15.77 mm) (Table 1).

On average, on the cultivars studied, between the fertilized and unfertilized variants there are some differences but not statistically insured. The 3rd fertilization variant (Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha, foliar application) determined a higher vigour than the other variants, respectively 33.88 mm, exceeding the trunk diameter obtained in unfertilized variant with 4.39 mm, and with 1.54 mm in variant 2 (Biohumus – 0,7 l/tree, soil application) (Table 1).

In conclusion, the highest vigour expressed by trunk diameter was obtained on 'Aura' and 'Rubinola' cvs. in 3rd fertilization variant - Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha, foliar application.

Similar results regarding the influence of the Biohumus on the vegetative growth of some apple cvs. were also reported by Călinescu et al., in 2022. Also, Milosevic et al., in 2019, reported similar results regarding the increase of the surface of the trunk section in case of applying organic fertilizers.

Table 1

The influence of fertilization variants on trunk diameter (Pitești-Mărăcineni, 2024)

No.	Cultivar	V1	V2	V3	Average/ cv.
1	Aura	43.00	45.56	45.50	**44.69 a**
2	Rumina	28.29	32.75	31.57	**30.87 b**
3	Jonaprim	13.98	16.32	17.02	**15.77 c**
4	Rebra	31.99	32.77	32.75	**32.50 b**
5	Rustic	27.24	31.74	33.40	**30.79 b**
6	Redix	29.15	34.37	36.31	**33.28 b**
7	Orion	26.36	28.04	32.98	**29.13 b**
8	Luna	26.75	30.16	31.77	**29.56 b**
9	Rubinola	40.14	42.40	42.83	**41.79a**
10	Topaz	33.73	37.14	40.84	**37.24 a**
11	Goldrush	27.28	28.43	31.74	**29.15 b**
12	Crimson Crisp	25.95	28.42	29.87	**28.08 b**
	Average/variant	**29.49 a**	**32.34 a**	**33.88 a**	**31.79**

* Duncan test.. The average values in a column that have the same letter, do not show significant differences (P≤0,05)

To assess the growth vigor, measurements regarding the trees height and the crown diameter were performed.

The average trees height had an average value of 205.69 cm, ranging from 248.33 cm to the 'Aura' and 'Rubinola' cvs. and 193.33 cm at the Jonaprim cv, between cultivars being very significant differences (Table 2).

Regarding the influence of the fertilization variants on the trees height, it can be seen from table 2 that there are no significant differences between the fertilization variants, the largest values of the trees height being in 3rd variant - Biohumus 0.9 l/tree (applied to soil before starting in the vegetation and autumn after the leaves fall) associated with Algacifo 3000 - 3 l/ha (applied foliar during the flowering and in the young fruit phases).

Table 2

The influence of fertilization variants on trees height (cm) (Pitești-Mărăcineni, 2024)

No.	Cultivar	V1	V2	V3	Average/cultivar
1	Aura	240	250	255	**248.33 a**
2	Rumina	200	210	215	**208.33 c**
3	Jonaprim	190	195	195	**193.33 c**
4	Rebra	230	230	240	**233.33 ab**
5	Rustic	240	250	250	**246.67 a**
6	Redix	200	210	210	**206.67 c**
7	Orion	220	230	230	**226.67 ab**
8	Luna	210	210	220	**213.33 c**
9	Rubinola	245	250	250	**248.33 a**
10	Topaz	220	230	225	**225.00 ab**
11	Goldrush	195	195	200	**196.67 c**
12	Crimson Crisp	240	250	250	**246.67 a**
	Average/variant	**219.17 a**	**225.83 a**	**228.33 a**	**205.69**

* Duncan test.. The average values in a column that have the same letter, do not show significant differences (P≤0,05)

The measurements regarding the crown diameter, made on two sides of the crown, highlighted the significant differences between cultivars and insignificant

between the fertilization variants. The most vigorous from this point of view were 'Aura', 'Rustic', 'Rebra' and 'Rubinola' cvs. (Table 3).

Fertilization variant 3 – Biohumus - 0.9 l/tree associated with Algacifo 3000 - 3 l/ha determined larger increases in the crown diameter (Table 3).

All the studied cultivars had the crown height greater than the two diameters, aspect due to the ceown shape - spindle.

Table 3

The influence of fertilization variants on crown diameters–D and d
(Pitești-Mărăcineni, 2024)

No	Cultivar	V1		V2		V3		Average/cultivar	
		D (cm)	d (cm)	D (cm)	d (cm)	D (cm)	d (cm)	D (cm)	d (cm)
1	Aura	120	115	130	120	130	125	**126.67 a**	**120.00 a**
2	Rumina	95	90	100	95	110	100	**101.67 bc**	**95.00 c**
3	Jonaprim	90	90	100	95	100	95	**96.67 c**	**93.33 c**
4	Rebra	120	110	130	120	135	125	**128.33 a**	**118.33 a**
5	Rustic	130	115	130	120	135	120	**131.67 a**	**118.33 a**
6	Redix	110	100	120	110	125	115	**118.33 b**	**108.33 b**
7	Orion	95	90	100	95	105	95	**100.00 c**	**93.33 c**
8	Luna	100	75	110	80	110	85	**106.67 bc**	**80.00 c**
9	Rubinola	120	100	125	105	130	110	**125.00 a**	**105.00 b**
10	Topaz	110	100	115	100	125	110	**116.67 bc**	**103.33 b**
11	Goldrush	90	85	95	90	100	90	**95.00 c**	**88.33 c**
12	Crimson Crisp	90	85	90	85	95	90	**91.67 c**	**86.67 c**
	Average/ variant	**105.83 a**	**96.25 a**	**112.08 a**	**101.25 a**	**116.67 a**	**105.00 a**	**111.53**	**100.83**

* Duncan test.. The average values in a column that have the same letter, do not show significant differences (P≤0,05)

The average number of annual shoots on the tree was 23.90 shoots/tree, the most annual shoots registering at 'Goldrush', 'Aura', 'Rubinola', 'Rebra' cvs., and the fewest were registered at 'Luna', 'Orion' and 'Crimson Crisp' cvs., between cultivars being significant differences.

Regarding the influence of fertilization variants on the number of annual shoots on the tree, it can be observed that there are no significant differences, the most annual shoots are also in 3rd variant – Biohumus - 0.9 l/tree, soil application associated with Algacifo 3000 - 3 l/ha, foliar application (Table 4).

The average length of the annual shoots was 45.63 cm, with variations between 67.61 cm at 'Aura' cv. and 27.54 cm at 'Jonaprim' cv (Table 4).

Fertilization variant 3 had a greater influence on the length of the shoots (Table 4).

The average yield on the tree at the cultivars studied was 11.37 kg/tree, ranging from 19.05 kg/tree at 'Luna' cv. and 4.85 kg/tree at 'Redix' cv., between cultivars being very significant differences (Table 5).

Among the fertilization variants were significant differences, the best fertilization variant being variant 3 - Biohumus 0.9 l/tree associated with Algacifo 3000 - 3 l/ha (Table 5).

Table 4

The influence of fertilization variants on number and lenght of annual shoots (Pitești-Mărăcineni, 2024)

No.	Cultivar	V1		V2		V3		Average/cultivar	
		No.	Length (cm)	No.	Length (cm)	No.	Length (cm)	No.	Length (cm)
1	Aura	25.33	64.85	27.66	67.50	31.00	70.48	**28.00 a**	**67.61 a**
2	Rumina	18.66	48.62	21.66	50.13	23.33	52.69	**21.22 b**	**50.48 b**
3	Jonaprim	22.00	26.42	25.33	27.58	27.66	28.62	**25.00 ab**	**27.54 d**
4	Rebra	26.33	46.80	28.66	49.45	31.00	52.70	**28.66 a**	**49.65 b**
5	Rustic	22.33	47.56	25.33	49.74	27.33	54.68	**25.00 ab**	**50.66 b**
6	Redix	18.66	35.66	20.33	36.00	24.33	38.42	**21.11 b**	**36.69 c**
7	Orion	15.66	26.35	18.66	27.98	21.33	29.85	**18.55 c**	**28.06 d**
8	Luna	13.33	30.38	16.66	31.57	19.33	34.80	**16.44 c**	**32.25 c**
9	Rubinola	25.00	60.48	29.33	64.86	34.33	68.80	**29.55 a**	**64.71 a**
10	Topaz	21.66	28.49	24.66	29.33	28.00	30.40	**24.77 ab**	**29.41 d**
11	Goldrush	30.33	62.87	33.33	68.94	37.66	70.25	**33.77 a**	**67.35 a**
12	Crimson Crisp	12.00	40.16	14.00	43.49	18.33	45.63	**14.78 c**	**43.09 c**
	Average/variant	**20.94 a**	**43.22 a**	**23.80 a**	**45.55 a**	**26.97 a**	**48.11 a**	**23.90**	**45.63**

*Duncan test. The average values in a column that have the same letter, do not show significant differences (P≤0,05)

Tabel 5

The influence of fertilization options on fruit production per tree (kg/pom) (ICDP Pitești, 2024)

No.	Cultivar	V1	V2	V3	Average/cultivar
1	Aura	8.78	9.68	10.01	**9.49 bc**
2	Rumina	6.59	7.24	8.43	**7.42 c**
3	Jonaprim	9.24	9.34	10.65	**9.74 bc**
4	Rebra	15.96	17.10	18.49	**17.18 a**
5	Rustic	11.48	12.95	13.71	**12.71 b**
6	Redix	4.56	4.64	5.34	**4.85 c**
7	Orion	15.79	17.25	17.96	**17.00 a**
8	Luna	17.96	19.02	20.18	**19.05 a**
9	Rubinola	9.35	9.50	11.25	**10.03 b**
10	Topaz	12.04	12.93	13.25	**12.74 b**
11	Goldrush	8.35	9.82	9.98	**9.38 bc**
12	Crimson Crisp	6.50	6.54	7.54	**6.86 c**
	Average/variant	**10.55 b**	**11.33 ab**	**12.23 a**	**11.37**

* Duncan test.. The average values in a column that have the same letter, do not show significant differences (P≤0,05)

CONCLUSIONS

Organic fertilization had a positive influence on growth and fruit production.

Biohumus applied at soil associated with Algacifo 3000 applied foliar had a positive effect on the growth and fruiting processes at apple.

As results of the investigations we found that:

- the highest vigour had ‘Aura’ (45.50 mm) and ‘Rubinola’ (42.83 mm) cultivars in 3rd fertilization variant (Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha, foliar application);

- the best results regarding the fruits yield were also obtained in the 3rd fertilization variant (Biohumus – 0,9 l/tree, soil application + Algacifo 3000 – 3 l/ha,

foliar application), among the cultivars being noted ‘Luna’ cv. with an average fruits yield of 20.18 kg/tree and ‘Rebra’ cv. with 18.49 kg/tree.

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