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BEHAVIOR OF APPLE TREES ON GENEVA SERIES ROOTSTOCKS ON LAND REPLANTED AFTER THE ORCHARD

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ABSTRACT

The investigations were carried out in the apple plantation of "Viorix-Agro" Ltd., in the spring of 2022. The trees, planted at a distance of 3.5x0.8 m and trained after the crown vertical axis, were grafted on rootstocks M9, G11 and G41 for Gala Nikangie cultivar and on rootstock G11 for Fuji King Grofn cultivar. The results showed that in order to obtain early apple yields and to maintain a rational relationship between vegetative macrostructure and yield microstructure, as well as to prevent soil fatigue in replanted land, it is recommended to use the vegetative rootstocks G11 and G41 in association with the perspective varieties.

INTRODUCTION

By the year 2025, apple culture is expected to occupy approximately 36% of the country's fruit heritage, with a share of over 70% in global fruit production. Of the total area occupied by apple, approximately 70% is located in the northern part of the country. Currently, rootstocks M9, 62-396, M26, MM106 are widely used when establishing apple orchards. Since the existing intensive orchards, established with various cultivar/rootstock combinations and recorded global production, no longer meet the demands of growers and consumers, it is necessary to establish new plantations with modern varieties and rootstocks. (Babuc et al. 2013; Balan V. 2009; Cimpoieş 2012; Peşteanu 2024).

The limited availability of new land for the establishment of apple orchards in the northern part of the country, the given species is replanted on land where it was previously cultivated without taking into account the phenomenon of "soil fatigue". (Babuc et al. 2013 Cimpoieş 2012; Peşteanu 2024). Replanting lands with grafted trees on M9, 62-396, M7, M26, MM106 rootstocks, without taking into account this phenomenon, leads to the reduction of the development of newly planted trees, the reduction of plantation productivity and fruit quality, as well as the increase of diseases such as white rot of roots, package rot, bacterial fire and woolly lice. (Hewavitharana 2019; Peşteanu 2024).

Worldwide, apple culture has undergone great changes with regard to the new assortment of rootstocks in the last 20 years, reaching remarkable performances today due to these characteristics in cultivation technology. (Fazio 2014; Peşteanu 2008; Robinson 2014).

The new rootstock breeding program at Cornell University in the USA offers fruit growers a wide range of biotypes in the CG series, characterized by stable

growth, high, constant and quality yields, wide branch insertion angles, replant disease resistance and insect disease. (Fazio 2014; Robinson 2014).

MATERIAL AND METHODS

The investigations were carried out in the apple plantation of the SRL "Viorix-Agro" enterprise, Trebisăuți village, Briceni district. The trees were planted in the spring of 2022, on a land where, in the fall of 2021, after the fruit was harvested, the 8-year-old apple orchard was cleared.

In order to study the behavior of trees of the Gala Nikangie cultivar grafted on M9, G11, G41 rootstocks and those of the Fuji King Grofn cultivar on the G11 biotype, on a replanted plot in the northern part of the Republic of Moldova, an experiment was set up to analyze the development of associations cultivar/rootstock under the influence of the "soil fatigue" phenomenon. The apple trees were imported from Holland. The planting material used for planting was of the "knip boom" type, two years old, with the crown formed by anticipated branches. The planting distance was 3.5x0.8 m, and the trees are driven according to the vertical axis crown.

During the research, the height and width of the crowns, the vegetative macrostructure, the fruitful microstructure and the productivity of the plantation were determined. Each variant included 4 replicates located on a randomized plot, with 8 trees in each replicate. The investigations were carried out in field and laboratory conditions, using methods recommended for experiments with fruit species.

The statistical processing of the main indicators was carried out by the method of monofactorial dispersion analysis, using the ANOVA test program package and STATGRAPHICS 18.0.

RESULTS AND DISCUSSIONS

The structure of the stem of the apple trees at the end of the first year of vegetation was influenced by the biotype of the rootstock and the biological peculiarities of the cultivar (table 1).

Gala Nikangie trees grafted onto M9 rootstock showed the highest trunk height, reaching 50 cm. Within the associations Gala Nikangie/G11, Fuji King Grofn/G11 and Gala Nikangie/G41, this indicator varied between 44 and 45 cm. The height of the trunk was influenced by the work carried out in field II of the apple tree nursery, where the trunk of the apple trees was cleared.

Table 1

The bioconstructive parameters of apple trees depending on the biological particularities of the cultivar/rootstock association, cm

Rootstock	Cultivar	Height				Coronal widthor
		trunk	axel	arrow	stem	
M9(m)	Gala Nikangie	50	100	55	205	113
G11	Gala Nikangie	44	100	45	189	110
	Fuji King Grofn	45	110	76	231	150
G41	Gala Nikangie	45	97	66	208	119

The height of the stem axis was more obviously correlated with the biological particularities of the cultivar, compared to those of the rootstocks taken in the study. For trees of the Gala Nikangie cultivar, the height of the axis varied between 97 and 100 cm, while for those of the Fuji King Grofn/G11 association, it was 110 cm,

marking an increase of 10.0-13.4% compared to the other cultivar/rootstock combinations.

Trunk and axis height are elements that reflect the development of trees in field II in the tree nursery, while the stem arrow represents a relevant index for the first year of vegetation in the orchard. The obtained results show that the highest value of stem arrow was obtained within the Fuji King/G11 cultivar/rootstock association, with 76 cm. Gala Nikangie trees grafted on G11 rootstock had a stem arrow of 45 cm, and those grafted on M9 and G41 biotypes showed average values of 55 and 66 cm, respectively.

The highest tree height in the studied variants was recorded at the Fuji King/G11 association, with 231 cm. Similar values were obtained in trees of the Gala Nikangie cultivar grafted on the rootstock M9 (205 cm) and on the biotype G41 (208 cm). Gala Nikangie trees grafted on G11 rootstock showed lower stem height values (189 cm).

The number of annual branches formed in the first year of vegetation in the apple plantation varied between 18 and 27 pieces/tree. The fewest annual branches were formed by trees from the association Fuji King Grofn/G11 (18 pcs) and Gala Nikangie/M9 (19 pcs), and the most annual branches were obtained within the associations Gala Nikangie/G41 (26 pcs) and Gala Nikangie/G11 (27 pcs), representing an increase of 42.1-44.4% (table 2).

The lowest number of annual branches were recorded within the association Gala Nikangie/M9 - 16.5 cm, where the number of annual branches within the crown was also reduced. In the association Gala Nikangie/G11, the average length of the annual branches was 21.8 cm, registering an increase of 32.1% compared to the control variant.

Table 2

The number, average and total length of branches of different ages in the crown of apple trees depending on the biological particularities of the cultivar/rootstock association

Rootstock	Cultivar	Number of branches, pcs/tree		The length average, cm		Total length, m/tree	
		annual	two years	annual	two years	annual	two years
M9(m)	Gala Nikangie	19	13	16.5	33.8	313	439
G11	Gala Nikangie	27	18	21.8	22.3	588	401
	Fuji King Grofn	18	16	47.8	35.9	860	574
G41	Gala Nikangie	26	16	23.6	26.0	613	416
LDS 0.05		1.34	0.65	1.47	1.02	1.02	10.6

The increase in rootstock development vigor (Gala Nikangie/G41) significantly influenced the average length of the annual branches, which reached 23.6 cm, representing an increase of 32.1% compared to the association Gala Nikangie/G11 and 43.0 % compared to the control variant.

The greater average length of annual branches was recorded in the association Fuji King Grofn/G11 (47.8 cm), which was 2.89 times greater compared to the control variant. Gala Nikangie/G11 and Gala Nikangie/G41 associations had average branch lengths of 1.32 and 1.43 times higher than the control variant, respectively.

The total length of the annual branches is correlated with the number of annual growths obtained in the crown of the trees and their average length recorded

during the first year of management. Lower values were obtained within the association Gala Nikangie/M9 (control) - 313 cm.

Greater total annual branch length was recorded in Gala Nikangie trees on G11 and G41 rootstocks with values of 588 cm and 613 cm, respectively, representing an increase of 87.8 and 95.8 respectively % compared to the Gala Nikangie/M9 association. In the association Fuji King Grofn/G11, the total length of the annual branches was 860 cm, marking an increase of 2.75 times compared to the control variant. Although the number of annual branches was lower in this association, due to the higher average annual length, the final value registered clearly higher levels compared to the other cultivar/rootstock associations studied.

The two-year-old branches formed in the crown of the trees from the second field of the orchard show that their number varied from 13 to 18 pieces. Smaller number of two-year-old branches in the crown of apple trees was registered in the association Gala Nikangie/M9 - 13 pieces. The associations Fuji King Grofn/G11 and Gala Nikangie/G41 are characterized by a greater number of branches per axis (16 pieces), an increase of 23.3% compared to the control variant. Within the trees of the Gala Nikangie/G11 association, the studied index recorded higher values (18 pieces), an increase of 38.4% compared to the control variant and 12.5% compared to the associations Fuji King/G11 and Gala Nikangie/ G41.

Lower values of the average length of the two-year branches were recorded in the association Gala Nikangie/G11 (22.3 cm), followed by the combinations Gala Nikangie/G41 (26.0 cm), Gala Nikangie/M9 (33.8 cm) and the Fuji King Grofn/G11 (35.9 cm). The combined two-year branch length of the trees in the studied associations Gala Nikangie/G11 and Fuji King Grofn/G11 ranged from 401 to 574 cm. The trees from the associations Gala Nikangie/G41 and Gala Nikangie/M9 recorded average values, constituting 416 and 439 cm, respectively.

A higher number of spurs (table 3) was recorded within the crown of the apple trees of the association Fuji King Grofn/G11 (20 pcs/tree), representing 60.6% of the total number of fruit formations. In Gala Nikangie/M9 and Gala Nikangie/G11 associations, the number of spurs was about the same, with 13 and 12 pcs/tree, representing 35.2% and 24.5%, respectively. The lowest number of spurs was recorded in the trees of the Gala Nikangie/G41 association, with 8 pcs/tree, which constituted 25.8%.

Table 3

The type of fruit formations in the crown of apple trees depending on the biological particularities of the cultivar/rootstock association

Rootstock	Cultivar	spurs		dards		brindilles		bourse	
		pcs/tree	%	pcs/tree	%	pcs/tree	%	pcs/tree	%
M9 (m)	Gala Nikangie	13	35.2	8	21.6	6	16.2	10	27.0
G11	Gala Nikangie	12	24.5	14	28.6	11	22.4	12	24.5
	Fuji King Grofn	20	60.6	4	12.1	2	6.1	7	21.2
G41	Gala Nikangie	8	25.8	4	12.9	9	29.0	10	32.3

The number of dards in the crown of the trees in the Fuji King Grofn/G11 and Gala Nikangie/G41 associations was 4 pcs/tree, representing 12.1% and 12.9%, respectively. The trees from the Gala Nikangie/M9 association formed 8 dards, representing 21.6%, and those from the Gala Nikangie/G11 association formed 14 pcs., representing 28.6% of the total fruit formations.

The biological peculiarities of the cultivar/rootstock association also influence the number of brindilles formed in the crown of the apple trees. A smaller number of brindilles was recorded in the trees of the Fuji King Grofn/G11 association (2 pcs/tree), representing 6.1%, and the highest number in the Gala Nikangie/M9 association (6 pcs/tree), representing 16.2%. More rationally, the vegetative macrostructure was garnished with brindilles in the associations Gala Nikangie/G41 and Gala Nikangie/G11, where their number was 9 and 11 pcs/tree, respectively, constituting 29.0% and 22, respectively, 4% of the total crown fruit formations.

The number of two-year fruit formations, represented by fruit bourses, varied between 7 and 12 pcs/tree, representing 21.2%-32.3% of the total weight of the formations. In the Fuji King Grofn/G11 association, the number of bourses was 7 pcs/tree (21.3%), and in the Gala Nikangie/M9 and Gala Nikangie/G41 associations, it was 10 pcs/tree, representing 27 .0% and 32.3% respectively. The largest number of fruit bourses was registered in the trees of the Gala Nikangie/G11 association, with 12 pcs/tree, constituting 24.5%.

The more rational garnishing with fruit formations during the research was observed in the crown of the trees in the Gala Nikangie/G11 association, where the share of spurs was 24.5%, dards 28.6%, brindilles 22.4% and fruit bourses 24.5%.

The fruit formations in the crown of the apple trees from the cultivar/ rootstock associations studied were predominantly obtained on two-year wood, that is, on the anticipated branches formed in field II of the apple nursery and on the tree axis.

The number of fruits formed within the trees in the studied associations was higher, but it was decided to keep approximately 5-6 fruits per tree to exclude the phenomenon of alternation of fruiting, frequently found in trees of the Fuji cultivar and its clones. The number of fruits in the crown varied from 4 to 7 pieces. The lowest number of fruits was recorded in the trees of the association Gala Nikangie/G41 (4 pcs), followed by Fuji King Grofn/G11 (5 pcs), Gala Nikangie/M9 (5 pcs), and the highest number was at Gala Nikangie/G11 (7 pcs) (table 4).

Table 4

The productivity of the apple plantation after the first year after planting in the apple culture depending on the biological particularities of the cultivar/rootstock association

Rootstock	Cultivar	Number of fruits, pcs/tree	Average weight, g	Production		Gap with the control variant, kg
				kg/tree	kg/ha	
M9 (m)	Gala Nikangie (m)	5	174	0.87	3110	0
G11	Gala Nikangie	7	168	1.18	4205	+1095
	Fuji King Grofn	5	238	1.19	4250	+1140
G41	Gala Nikangie	4	195	0.78	2780	-330
LDS 0.05		0.15	8.1	0.04	13.2	-

A higher average fruit weight was recorded in the association Fuji King Grofn/G11 (238 g) compared to Gala Nikangie grafted on G11 rootstock (168 g), where the lowest index was obtained. This significant difference is explained by the biological peculiarities of the varieties studied and the number of fruits kept in the crown.

The biological peculiarities of the rootstock also influence the average weight of the fruit. Higher values of the studied index were recorded in the association Gala

Nikangie/G41 (195 g), followed by Gala Nikangie/M9 (178 g) and Gala Nikangie/G11 (168 g).

Higher yields were obtained from Fuji King Grofn (1.19 kg) and Gala Nikangie (1.18 kg) trees grafted onto G11 rootstock. Depending on the rootstock, higher values of the studied index were obtained within the association Gala Nikangie/G11 - 1.18 kg, followed by Gala Nikangie/M9 - 0.87 kg and Gala Nikangie/G41 - 0.78 kg, representing an increase of 35.6% and 66.1% respectively compared to the last two combinations.

Overall production within the plantation ranged from 2780 to 4250 kg/ha. Higher values of fruit production per unit area were obtained in the variants Fuji King Grofn/G11 (4250 kg/ha) and Gala Nikangie/G11 (4205 kg/ha), the difference being also confirmed by statistical data. Lower global production was recorded in the associations Gala Nikangie/G41 (2780 kg/ha) and Gala Nikangie/M9 (3110 kg/ha).

The investigations carried out on the fruit production obtained during the research showed that it is correlated with the biological peculiarities of the rootstock, and the action of the cultivar was not significantly highlighted.

CONCLUSIONS

The results obtained from experimental research after the first year of vegetation allow us to mention that, in order to have a rational ratio in the crown between the vegetative macrostructure and the fruiting microstructure, to obtain early apple harvests, and to exclude the phenomenon of "soil fatigue" on the land where replanting has been carried out, the use of Geneva 11 and Geneva 41 vegetative rootstocks in association with perspective varieties is recommended.

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