The influence of tree formation methods on development and placement of generative organs in apple orchard

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Abstract The experiment was carried out in a commercial orchard "Codru-St" Ltd. founded in 2000 with bench-graftings. Apple trees of the varieties Gala Must, Golden Reinders and Idared were grafted on dwarfing M9 rootstock. The distance of plantation between rows is 4.0 m, and between trees in the row is 1.0 m. There were studied 4 variants (method) of crown formation. From 2002 to 2006 were studied the quantity of bud-fruit formations, bud-fruit formation type, their located on different age branches and fruits location on different branches in dependence of slender spindle crown formation methods.

It was established that on the studied varieties, the highest cumulated quantity of bud-fruit formations formed variety Gala Must 667-876 pcs and in function of crown formation in the variants with minimize of pruning degree at crown formation and design of 2 provisional horizontal branches through fixation on row direction were was established an increase of the 15-31% in comparison with control variant. At the studying varieties and methods of crown formation during 2003-2005 years the spurs share constitute 40-46%, the multi-annual spurs 38-45%, thorns and rods average 6-9%. Studying the investigated variants of crown formation, there were no significant differences in location of the bud-fruit formation on different branches. Location of the fruits on different age branches, as the bud-fruit formations is a hereditary characteristic of the variety. At the varieties of III type of fructification, grafted on M9 rootstock, the fruits mostly were located on the young branches with ages of 1-3 years. Investigation of the fruits and bud-fruit formations located on the different age branches permitted to recommend pruning degree of the fruit-bearing branches for maintaining the correlation between the growth and the fructification.

Key words

Apple Tree, Varieties, Orchard, Bud-fruit formation, Different age branches, Fruits

The main objective of crown formation consists in urgenting of trees on economic bearing and crop rapid growth of young fruit trees.

In general, this objective is done through formation in the shortest time of macrostructure (skeleton), according to the management system of trees and garnishing them at maximum with microstructure – skeleton and fruit bearing branches, including the formation free space of microstructure provisional branches. After entering these economic bearing trees, for reduction by pruning, gradually diminishes while increasing the volume of crown and fruit yield up to full fruition [4, 6].

The applicative part of these objective are met by minimising the cuts, especially shortening branches during biological recovery, the transfer of cutting and other operations mainly in vegetation, including the orientation in free space of shoots and branches with vertical guidance by forced transfer or inclined cutting [1, 3, 7, 8, 9].

Materials and Methods

Experimental plot is located in the orchard „Codru-ST" Ltd. Planting was conducted in spring 2000 with the bench graftings on the rootstock M9 of Must Gala, Golden Reinders, Idared varieties. The distances between rows 4.0 m and between trees in row 1.0 m.

In 2000 vegetation grafts reached about 120 cm which allowed initiation of slender spindle crown formation in four variants.

Variant 1 (control) - as recommended in force: the trunk of the trees with 50 - 55 cm and well-developed vertical few zigzag shaped axis; 3-4 frameworks 40 - 50 cm short with inclination angles of about 60^{o} to the vertical; the scaffold branches and

above the axis at intervals of 20 cm are uniformly located radically fruit-bearing branches, after fructification fruit-bearing branches is to renew the cycle of 3 - 4 years.

Variant 2 - Crown bioconstructive base as in the control variant completed with: rational minimizing of the degree of training cuts, placement above the crown of the provisional scaffold branches alternatively horizontalized fixed on espalier onto the row direction that gradually shortens after fructification stage, transferring them into fruit branches; forced horizontalization of vertically growing scions and branches into the free end of the crown to transfer into fruit branches.

Variant 3 - Formation of a crone is made as in variant 2 routing the fruit-bearing branches to horizontal position through lateral transfer side parting cuts.

Variant 4 - Formation of a crone basically is made as in variant 2 with the renovation of branches by division fruit-bearing to obtain scions from sleeping buds.

From 2002 to 2006 was studied the quantity of bud-fruit formations, bud-fruit formation type, their located on different age branches and fruits location on different branches in dependence.

Results and Discussions

The number of bearing formation grows more intensively and has higher absolute Gala Must of force over average trees (table 1).

In average on the years 2002-2005 at this variety in variant 1 (control), the number of bearing formation constitutes 667 pcs/tree.

Slower growth intensity and smaller absolute values of fruit formation occurred in Golden Reinders variety. In control variant the amount bearing formations at this variety, the amount for years 2002-2005, constitutes 612 pcs/tree being with 10 % smaller than Gala Must.

Table 1

The average number of fruit formations depending of crown formation method, pcs/tree

Method of crown formation	years				sum	%
	2002	2003	2004	2005		
Gala Must variety						
Variant 1 (control)	116	175	195	191	667	100
Variant 2	134	201	269	272	876	131
Variant 3	127	187	199	250	756	113
Variant 4	113	180	196	230	719	107
Golden Reinders variety						
Variant 1 (control)	94	121	210	187	612	100
Variant 2	112	154	262	251	779	127
Variant 3	104	137	222	228	691	113
Variant 4	96	120	202	218	636	104
Idared variety						
Variant 1 (control)	64	135	134	179	512	100
Variant 2	78	164	147	201	590	115
Variant 3	79	140	138	194	541	106
Variant 4	62	129	120	174	485	96

At Idared variety the increasing intensity and absolute values of number bearing formations are about 30 % than Gala Must. The amount of fruit formation, in variant control, for the years 2002-2005, is 512 pcs/tree. In this version the number of bearing formations in the 2002-2005 years are 876 pcs/tree Gala Must, 779 pcs/tree Golden Reinders and 590 pcs/tree Idared, being higher with 31%, 27% and 15% from the variant control.

Similar results on increasing the number of bearing formations in the horizontally tree branches were recorded in the researches of Т.М. Костюченко [8], С. Мавродиев and С. Гандев [9].

The significant increase in the number of bearing formations in version 2 is due to reasonable minimize the degree of the tree cutting, additional training above the base to crown of two provisional branches, the horizontalization in free space tilt forced of shoots and branches with the direction to the vertical positions.

The slower increase in the number of fruit formations was in variant 3, where the horizontalization of branches and shoots to vertical was made by cutting transfer. Through it was reduced some of the branches which grow fruit formations.

In sum, for the years 2002-2005 the number of bearing formation in version 3 are: 756 pcs/tree Gala must, 691 pcs/tree Golden Reinders and 590 pcs/tree

Idared, control version being overcome with 13%, 12% and 6%.

In version 4, with division of branches from 2-3 years with the aim to obtain the wound around the buds of shoots oriented horizontally, in most cases the number of fruit formation is lower than the control, especially in 2002-2004, because, with divided branches were removed some bearing formations. In sum, for the years 2002-2005 the number of fruit formations on a tree from version 4 does not differ significantly (96-107%) to version control.

The conclusion is that the rational minimization of a control training cutting trees, location above the base of the 2 branches provisional crown oriented to wards the line, orientation in free space by tilting of branches and shoots with the vertical orientation, contributing to an increase average of bearing formations varieties about 24% which is to speed entry and young trees in bearing and raising economic yield fruit.

The type of fruit formations and the report between them are hereditary features of the varieties, which are not great modify by the influence of ecological and technological factors, including the training and pruning system [1, 5, 6].

The Gala Must, Golden Reinders, Idared varieties have the third type of fructification, standard or Golden Delicious named, which are characterised of the fruit bud formation on spurs, thorns, rods and multi-annual spurs [2, 3, 5], but on midget rootstock grafted trees, the more fruit buds are forming on good developed shoots axial buds, especially, which have an horizontal orientation [8, 9].

The research results (table 2) demonstrate that at all studied varieties and variants the spur and scholarships bearing are most present fruit formations. The weight of spurs in studied variants, at Gala Must and Idared varieties in average per 2003-2005 years, is in limits of 40-46%, but the weight of scholarships bearing – 38-45%, the stakes and sticks have only 6-9%.

The weight of spurs, at Golden Reinders variety, is more comparative than Gala Must and Idared varieties, in average of 2003-2005 years and of crown formation variants being 47-53%, but of multi-annual spurs bearing is smaller – 29-32%. The weight of thorns and rods is only 10-13% and respectively 9-12% being bigger than Gala Must and Idared varieties, which is characteristic for this variety [2].

Table 2

The type of fruit formations depending of the variety and crown formation method, average for 2003-2005, %

Method of crown formation	spurs	thorns	rods	multi-annual spurs
Gala Must variety				
Variant 1 (control)	46	7	9	38
Variant 2	42	9	8	41
Variant 3	43	7	9	41
Variant 4	41	7	7	45
Average	*43,0*	*7,5*	*8,3*	*41,2*
Golden Reinders variety				
Variant 1 (control)	49	10	12	29
Variant 2	47	12	9	32
Variant 3	51	13	9	27
Variant 4	53	10	10	27
Average	*50,0*	*11,3*	*10,0*	*27,8*
Idared variety				
Variant 1 (control)	40	7	6	47
Variant 2	44	6	6	44
Variant 3	45	7	8	40
Variant 4	43	8	8	41
Average	*43,0*	*7,0*	*7,0*	*43,0*

The location on branches bearing formations of different ages is a dominant characteristic for the variety of hereditary properties. But a reasonable range can changed under the influence of ecological and technological factors.

One of the most effective technological factors of change in location of bearing formations is building upon the tree cutting, which largely provides branches of fruit aging rejuvenation with potential low fructification for building upon and regulating the load bearing formations [5, 7, 10].

Table 3

The fruit formations location depending of the crown formation method, %

Method of crown formation	year 2003		year 2004			year 2005		
	Age of branches, years							
	2	3	2	3	3<	2	3	3<
Gala Must variety								
Variant 1 (control)	60,0	40,0	68,8	18,0	13,2	50,1	29,9	20,5
Variant 2	54,2	45,8	40,9	43,5	15,6	47,3	31,7	21,0
Variant 3	57,1	42,9	58,4	15,6	26,0	49,1	30,3	20,6
Variant 4	59,8	40,2	43,3	32,2	24,0	51,0	31,9	17,0
Golden Reinders variety								
Variant 1 (control)	71,1	28,9	76,2	15,2	8,6	42,4	44,8	12,8
Variant 2	61,1	38,9	64,9	26,7	8,4	41,1	43,9	15,0
Variant 3	68,2	31,8	72,9	19,4	7,7	43,9	45,4	10,7
Variant 4	72,1	27,9	72,2	13,9	13,9	44,7	44,1	11,2
Idared variety								
Variant 1 (control)	52,5	47,5	48,5	38,0	13,5	49,3	36,0	14,2
Variant 2	48,8	51,2	37,5	47,7	14,8	43,1	39,4	17,5
Variant 3	55,1	44,9	61,9	27,9	10,2	45,2	40,2	14,6
Variant 4	53,7	46,3	53,4	31,6	15,0	48,1	38,3	13,6

Varieties of type 3 of fructification is characterised the location of bearing formations mainly on young branches of 2-3 years [2, 4, 5].

Gala Must and Idared varieties in similar ecological and technological conditions, averaged over 2003-2005 and studied variants, 52-53 % of total bearing formations are located on branches 2 years 36-39% - on branches 3 years and only 9-11% on branches older than 3 years.

The Golden Reinders variety trees have located on branches 2 years around 61% of bearing formations or 8-9%more that Gala Must and Idared. On the ranches 3 years the localization of bearing formations is 4-7% lower that the varieties listed and accounted on average for years and variations in the study, 32%. On the branches older than 3 years are only 7% of all bearing formations.

Table 4

The fruit location depending of branch age,%

Method of crown formation	Average per 2004-2006 years			
	The branch age, years			
	1	2	3	>3
Gala Must variety				
Variant 1 (control)	40,2	37,8	15,7	6,5
Variant 2	41,6	36,8	14,8	6,8
Variant 3	43,9	35,4	15,8	5,6
Variant 4	39,3	37,4	16,7	6,6
Golden Reinders variety				
Variant 1 (control)	40,5	39,2	12,8	7,5
Variant 2	45,0	35,8	13,5	5,7
Variant 3	43,1	34,5	17,1	5,3
Variant 4	43,0	34,6	15,2	7,2
Idared variety				
Variant 1 (control)	53,2	29,5	11,8	5,5
Variant 2	55,0	26,4	14,2	4,4
Variant 3	51,9	27,4	14,8	5,9
Variant 4	48,2	31,5	13,8	6,5

Variations depending on the studied crown formation, there were no significant differences in location of bearing formations.

The average of the fruit formations weight, situated on 2 years old branches, during 2003-2005 years, at versions 1(control), 3 and 4, is 55-57%, on 3 years old – 33-36 %, and older 3 years – 10-11%.

The decrease of fruit formation, situated on 2

years old branches, were recorded only in version 2, in average of years and varieties to 51%, or with 6% less control.

The quantity of fruit formation, on 3 year old branches was increased to 40% or with 7% much more then control. The total number of fruit formation situated on older 3 years branches is to 9%. The decrease of fruit formation on 2 years old branches is because a part of these branches were formed in last year much more fruit buds on horizontal branches which were developed fruits, but not fruit formation. The outrunning by about 7% of fruit formations on 3 years old branches is of provisional microstructure branches.

A great part of fruit buds were formed, at all studied varieties, of axial buds of shoots which were fructified in following year (table 4).

The location of fruits and of fruit formation on different old branches is a hereditary feature of variety. The great part of fruits, at 3 fructification type varieties, especially grafted on dwarf rootstock (M9) is located on young branches, downward at 1 to 3 years old.

The information about of the fruits location on different old branches is used to establish the rational quantity of fruits, with trees cutting and other technological proceeds [5, 10].

The number of fruits at Gala Must and Golden Reinders varieties trees, located on 1 years old branches average over 2004-2006 is 41-43%, on 2 years old branches – 36-37%, on 3 years old branches – 14-16% and older thon 3 years - only 5-6% of all fruits.

The Idared varieties form on annual branches about 52% fruits or 9-11% more than Gala Must and Golden Reinders. The weight of fruits located on 2 years is 7-8% lower compared to those varieties and is 29%. The branches of 3 years old are located 14% and those older than 3 years – only 5% of the total number of tree fruits.

The variants of crown formation studied, the location of fruits depending on the age of fruit branches do not differ essentially (2-5%).

Conclusions

The increase in average bearing for motions varieties is contributed on about 24% by the minimization the extend of tree cutting training and placement above the base of the two branches provisional crown, facing the row direction and in space by tilting horizontalization of forced shoots with upright branches and which is to speed entry and the young trees in bearing and raising economic yield of fruits.

At the varieties of III type of fructification, grafted on M9 rootstock, the fruits mostly were located on the young branches with ages of 1-3 years. Investigation of the fruits and bud-fruit formations located on the different age branches permitted to recommend pruning degree of the fruit-bearing branches for maintaining the correlation between the growth and the fructification.

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