

The Productivity of Plum, Apricot and Cherry Trees Trained According to Improved Bush Type of Tree Crown

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Abstract: Increasing the productivity of the plum, apricot and cherry plantations and reducing the expenses for fruit production is the most current problem in the cultivation technology of these species. For this purpose, it has been studied a new tree crown form – improved bush. During a period of 7 years, there have been carried out the following investigations: evaluation of plantation productivity depending on the variety and crown form, determination of the bio construction parameters of the improved bush type of crown form and establishment of the method of tree cultivation. The obtained data show that the improved bush type of tree crown, due to the higher number of trees on a given surface, increases plantation productivity by 1,45 -2,0 times compared with the existing orchards. 97% of fruits of the apricot and cherry trees trained according to this type of crown form were distributed on the 1-year-old and 3-year-old branches. For the plum trees, the 4-year-old branches have a special importance as about 12,2 up to 14,6% of the total fruits were distributed on these branches. The productivity of plum and cherry species was higher when trees have been trained according to improved bush with 5 branches, while for apricot trees – with 4 branches. When pruning for fructification the trees trained according to improved bush, the semi-skeletal branches of apricot and cherry trees should be replaced with the 4-year-cycle and those of plum trees with the 4 or 5-year-cycle.

Keywords: apricot trees, cherry trees, productivity, tree crown, varieties

INTRODUCTION

The main direction in intensifying the cultivation of fruit tree species is to increase the number of trees on a given surface on the basis of reducing the growth vigour (Babuc, 2012; Balan, 2009; Cimpoies, 2012).

The most current issue in the cultivation technology of stone fruit tree species is the reduction of tree crown parameters. Larger tree crown forms decrease the economic efficiency of fruit production because of the increased expenses for tree pruning and fruit harvesting.

The most expensive operation is the fruit harvesting from large trees which represents up to 70-80% of the total expenses for the cherry and sweet cherry production (Chira *et al.*, 2006; Donica *et al.*, 2007).

The lack of reduced vigour rootstocks for such species as plum, apricot and cherry trees determined the producers to use the most efficient methods of growth vigour reduction, i.e. the agro-technical ones: tree crown formation, tree pruning and implementation of growth regulators (Cimpoies, 2000; Hrotko *et al.*, 2008; Istrati, 2008; Sitarek, 2006).

One of the tree crown forms that reduces the height of trees is improved bush, which was studied for apple trees and other fruit tree species (Budan *et al.*, 2000; Cepoiu *et al.*, 2008; Mica, 2010).

In this context, the study of stone fruit tree species trained according to improved bush type of tree crown is of special interest.

MATERIAL AND METHOD

In 2005, with the purpose of determining the productivity of stone fruit tree species trained according to improved bush type of tree crown, it was initiated an experiment at the Didactic Experimental Station "Criuleni".

Cherry trees have been trained according to improved bush with 3, 4 and 5 branches and planted at a distance of 5×2 m. The witness group included the trees trained according to mixed pyramid crown form and planted at a distance of 6×4m.

Apricot trees were planted at a distance of 5×2m and trained according to improved bush with 4, 5 and 6 branches. The witness group included the trees trained according to dwarf pyramid and planted at a distance of 6×4 m.

Cherry trees were planted at a distance of 5×2 m and trained according to improved bush with 3, 4 and 5 branches. The witness group included trees trained according to mixed pyramid and planted at a distance of 6×4 m.

The experiment was founded in 3 repetitions, each repetition representing 8-10 fruit trees.

The researches have been carried out according to methods widely used in the field of fruit-growing. The average number of fruits per 1 tree was determined by counting them on all trees included in the study 2-3 weeks before the harvest. For cherry trees, the yield was determined by weighing the harvested fruits and the number of fruits was calculated by counting them in 1 kg and then reporting to 1 tree.

Statistical processing of the results obtained in the scientific investigations was made according to Dospekhov (1985) using the computer.

RESULTS AND DISCUSSIONS

The obtained experimental results (Tab. 1) prove that the number of fruits depends first of all on the tree age and climatic conditions. Thus, in spring 2009, although the apricot trees had a sufficient number of flowers to obtain a good fruit yield, later spring frosts compromised the yield and in 2009 there haven't been any fruits.

All the species yielded in the 4th year after plantation and the number of fruits depended mostly on the variety than on the species. Thus, the number of fruits of the plum trees trained according to the existing recommendations, didn't vary significantly and constituted about 32-33 fruits/tree, depending on the variety. The number of fruits on the apricot trees of Bucuria variety trained according to dwarf pyramid, was about 2.46 times higher than for Krasnoshcekiy variety. For this species, the number of fruits of both varieties was higher compared with the plum trees.

Cherry trees trained according to mixed pyramid recorded the highest number of fruits for Erdi Böttermo variety also being the highest among all the species and 1.41 times higher than for Uifehertoi Fiurtosi variety.

In the year when trees yield, the fact that the trees were trained according to improved bush influenced the number of fruits depending on the species and variety.

For the plum trees of both varieties, trained according to improved bush method with 4 and 5 branches, the number of fruits was higher compared with the mixed pyramid of tree crown. Thus, if the trees of Stanley variety trained according to mixed pyramid recorded 33 fruits per tree, then the trees trained according to improved bush with 4 and 5 branches recorded respectively 55 and 34 fruits/tree. The number of fruits on the trees trained according to improved bush with 3 branches for both varieties wasn't recorded statistically compared with the witness group.

The number of fruits on the apricot trees of Krasnoshekiy variety trained according to improved bush increased with increasing the number of branches compared with the trees trained according to mixed pyramid. But in this case too, for the trees trained according to improved bush, the increasing number of fruits compared with the witness group wasn't recorded statistically. For trees of Bucuria variety, trained according to improved bush, the number of fruits is equal or smaller than of those trained according to dwarf pyramid, or smaller when they were formed of 4 branches.

For cherry trees of both varieties, trained according to improved bush, regardless the number of branches, the number of fruits was smaller compared with the trees trained according to mixed pyramid. If, for example, the trees of Uifehertoi Fiurtosi variety trained according to mixed pyramid yielded about 191 fruits/tree, then for the trees trained according to improved bush, the number of fruits varied depending on the number of branches from 57 up to 83 fruits/tree.

In the 5th year after plantation, all the species, except the apricot trees yielded a significantly higher number of fruits, both the trees trained according to the existing recommendations and those trained according to improved bush type of tree crown.

The varieties of plum trees differ by the number of fruits. If, for example, the trees of Kabardinskaia Ranniaia trained according to mixed pyramid yielded 513 fruits/tree then those of Stanley variety - 596 fruits/tree.

The cherry trees, in the 5th year after plantation, compared with the 4th year, recorded a higher yield in the case of Uifehertoi Fiurtosi variety. If, for example, the trees of Erdi Bõtermo variety trained according to mixed pyramid recorded a yield of 1206 fruits/tree, then those of Uifehertoi Fiurtosi yielded 1533 fruits/tree. It also should be mentioned that if in the 4th year after plantation certain variants of trees trained according improved bush recorded a higher number of fruits per tree compared with those trained according to the existing recommendations then in the 5th year after plantation, regardless the species and variety, the value of this index is smaller compared to the witness group. For example, in 2009, the plum trees of Kabardinskaia Ranniaia variety trained according to mixed pyramid recorded 513 fruits/tree while for those trained according to improved bush, this number varied depending on the number of branches from 179 up to 332 fruits/tree.

In the next 2 years, the number of fruits on the trees trained according to improved bush type for the studied species and varieties was similarly smaller compared to the trees trained according to the existing recommendations.

The number of branches influenced significantly the value of this index. However, we should mention that this influence varies depending on the variety and age of trees. Thus, for the plum trees of Kabardinskaia Ranniaia variety, the number of fruits, in the first year when fructification was recorded, increased on the trees trained according to improved bush with 5 branches, while the trees of Stanley variety – when being trained according to improved bush type with 4 and 5 branches. Thus, if the trees of this variety trained according to improved bush type with 3 branches recorded 38 fruits/tree then those with 4 and 5 branches recorded respectively 55 and 77 fruits/tree.

In the first year of fructification, the number of fruits on the apricot trees of Bucuria variety increased when training trees according to improved bush with 5 branches compared those with 4 branches.

The increase of the number of branches up to 6 didn't contribute to the increase of the number of fruits. That year, the increase of the number of fruits while increasing the number of branches for Krasnoshekiy variety trees wasn't recorded statistically and constituted from 118 up to 139 fruits/tree.

Tab. 1

Number of fruits on the plum, apricot and cherry trees depending on the variety and crown form, fruits/tree, the age of trees 4-7 years, DES "Criuleni"

Variety	Crown form	Number of branches, pieces	Years				Sum
			2008	2009	2010	2011	
Plum trees							
Kabardinskaia Ranniaia	Mixed pyramid (witness)		32	513	598	347	1490
	Improved bush	3	39	179	409	278	905
	Improved bush	4	48	260	486	321	1115
	Improved bush	5	59	332	488	350	1229
Stanley	Mixed pyramid (witness)		33	596	783	536	1948
	Improved bush	3	38	296	513	387	1234
	Improved bush	4	55	447	609	430	1541
	Improved bush	5	74	505	605	432	1616
<i>Dl_{0,05}</i>			13.8	22.6	21.6	23.0	
Apricot trees							
Bucuria	Dwarf pyramid, (witness)		251	-	984	832	2067
	Improved bush	4	214	-	444	631	1289
	Improved bush	5	262	-	436	632	1330
	Improved bush	6	232	-	552	594	1378
Krasnoshcekiy	Dwarf pyramid (witness)		102	-	899	711	1712
	Improved bush	4	118	-	433	466	1017
	Improved bush	5	134	-	370	452	956
	Improved bush	6	139	-	441	363	943
<i>Dl_{0,05}</i>			24.5	-	21.6	50.4	
Cherry trees							
Uifehertoi Fiurtosi	Mixed pyramid (witness)		191	1533	1622	4565	7911
	Improved bush	3	57	540	1265	3654	5516
	Improved bush	4	76	709	1382	3918	6085
	Improved bush	5	83	879	1623	3871	6456
Erdi Böttermo	Mixed pyramid (witness)		277	1206	1921	4500	7904
	Improved bush	3	27	463	1302	3435	5227
	Improved bush	4	39	513	1589	4018	6159
	Improved bush	5	43	681	1706	3913	6343
<i>Dl_{0,05}</i>			16.3	35.6	136.7	80.1	

The number of fruits on the cherry trees of Uifehertoi Fiurtosi variety increased while training trees according to improved bush with 4 branches compared with training trees with 3 branches. Further increase of the number of branches up to 5 didn't contribute to the increase of the number of fruits compared with improved bush formed of 4 branches. Therefore, if the trees of Uifehertoi Fiurtosi variety trained according to improved bush with 3 branches yielded 57 fruits/tree, then those formed of 4 and 5 branches recorded respectively 75 and 83 fruits/tree.

The trees of Erdi Böttermo variety recorded a higher number of fruits only when being trained according to improved bush type with 5 branches compared with those formed of 3 branches.

In the next fructification years 2009 and 2011 we stated that the number of fruits on the plum trees of Kabardinskaia Ranniaia variety increased while increasing the number of branches and in 2010 – only when training trees according to improved bush with 4 branches.

Stanley variety trees recorded in 2009 an increased number of fruits when increasing the number of branches, reaching its highest values when trees were trained according to improved bush with 5 branches – 505 fruits/tree. The same variety, in 2010-2011, recorded an increased number of fruits only for improved bush type of tree crown with 4 branches compared with improved bush with 3 branches. The increase of the number of branches from 4 to 5 in the case of this variety didn't contribute to the increase of the number of fruits.

For the apricot trees of both varieties the number of fruits didn't increase while increasing the number of branches.

The cherry trees of Uifehertoi Fiurtosi variety, in 2009 and 2010, recorded the highest number of fruits on the trees trained according to improved bush with 5 branches, while in 2011 – for improved bush with 4 branches. In 2009, for example, the trees trained according to improved bush with 3 branches yielded 540 fruits/tree while the same variant with 4 and 5 branches – respectively 709 and 879 fruits/tree.

In 2009, the trees of Erdi Bötérmo variety recorded the highest number of fruits when the trees were trained according to improved bush type of tree crown with 5 branches and similarly in 2010 and 2011 when it was formed of 4 branches.

Given that the highest number of fruits, depending on the number of branches, varied during the studied years, in order to determine the optimum number of branches it is necessary to know the total number of fruits yielded during the studied years depending on the number of branches.

The analysis of total data obtained during the studied years proves that the number of fruits of the plum and cherry tree varieties increased when increasing the number of branches. Thus, the cherry trees of Uifehertoi Fiurtosi variety trained according to improved bush with 3 branches recorded, during the years of fructification, the total number of 5516 fruits/tree, while those with 4 and 5 branches – respectively 6085 and 6456 fruits/tree.

Apricot trees of Krasnoshcekiy variety trained according to improved bush type recorded the highest number of fruits in the variant with 4 branches. The increase of the number of branches on this variety didn't contribute to the increase of the number of fruits.

Apricot trees of Bucuria variety recorded the highest number of fruits for the trees trained according to improved bush with 5 and 6 branches.

Based on this, we can conclude that it is advisable to train plum and cherry trees according to improved bush with 3 branches and the apricot trees of Bucuria and Krasnoshcekiy varieties – respectively with 4 and 5 branches.

In order to elaborate the tree pruning technique it is important to analyze the distribution of fruits on the branches of different age (Tab. 2).

For plum and cherry trees, most fruits were distributed on the 2-year-old branches and constituted, for the trees trained according to the existing recommendations, respectively 52.8 and 54.8%. But, for plum trees, the 2nd place represented 3-year-old branches and the 3rd and 4th places – 4-year-old and older branches and 1-year-old branches.

For apricot trees the share of 3-year-old and 1-year-old branches is practically the same and even less fruits were distributed on the 4-year-old and older branches. Thus, for the trees trained according to dwarf pyramid 20.2 and 18.9% of the total number of fruits were distributed respectively on the 3-year-old and 2-year-old branches and only 8.1% of them on the 4-year-old and older branches.

The highest number of fruits on the cherry trees compared with the plum and apricot trees were distributed on the 3-year-old branches. On the 2nd place, when discussing about the

number of distributed fruits, there were the 2-year-old branches. It is important to mention that about 95% of the total number of fruits was distributed on the 2-year-old and 3-year-old branches of cherry trees. The share of 1-year-old, 4-year-old and older branches concerning the yield of fruits is insignificant.

Only the apricot trees of Krasnoshcekiy variety recorded the influence of tree crown form on the distribution of fruits on the branches of different age. Thus, for the trees trained according to improved bush type of tree crown the number of fruits distributed on the 1-year-old branches is higher than on.

Tab. 2

The distribution of fruits on branches of different age for plum, apricot and cherry trees depending on the variety and crown form, %, the year 2011, the age of trees 7 years, SDE "Criuleni"

Species	Variety	Crown form	Number of branches, pieces	Age of branches, years			
				1	2	3	≥ 4
Plum	Stanley	Mixed pyramid (witness)		10.0	54.8	22.6	12.6
		Improved bush	3	9.4	55.7	20.3	14.6
		Improved bush	4	10.2	56.3	19.7	13.8
		Improved bush	5	11.0	59.5	17.3	12.2
Apricot	Krasnoshcekiy	Dwarf pyramid (witness)		18.9	52.8	20.2	8.1
		Improved bush	4	30.3	48.8	18.5	2.4
		Improved bush	5	32.7	50.2	15.2	1.9
		Improved bush	6	36.2	48.4	14.0	1.4
Cherry	Uifehertoi Fiurtosi	Mixed pyramid (witness)		2.8	43.5	52.4	1.3
		Improved bush	3	2.4	43.3	53.7	0.6
		Improved bush	4	2.0	45.1	52.9	-
		Improved bush	5	2.8	47.0	50.2	-

those trained according to dwarf pyramid. Therefore, about 18.9% of the total number of fruits were distributed on the 1-year-old branches of trees trained according to dwarf pyramid and 30.3 up to 36.2% of fruits were distributed on the trees trained according to improved bush type depending on the number of branches.

It should be also mention that for this variety the crown form influenced also the distribution of fruits on the 4-year-old and older branches. If, for example, 8.1% of the total fruits were distributed on the 4-year-old and older branches of the trees trained according to dwarf pyramid, then only 1.4-2.4% of the total fruits were distributed on the same branches for trees trained according to improved bush.

Taking into consideration the peculiarities of fruits distribution on branches of different age, we can conclude that for apricot and cherry trees trained according to improved bush type of tree crown more than 97% of fruits were distributed on the 1-year-old and 3-year-old branches. An important contribution to the yield of plum trees is due to the 4-year-old and older branches, as about 12.2 up to 14.6% of the total number of fruits were distributed on them. As a result, it can be concluded that it would be more reasonable to prune the apricot and cherry trees replacing the semi-skeletal branches with the 4-year-cycle and those of plum trees with the 4 or 5-year-cycle.

Taking into consideration that the density of plants differs in our experiment and in order to assess correctly the influence of studied factors, it is important to determine the fruits yield on a unit of plantation surface (Tab. 3).

Tab. 3

Fruit production in the plantations of plum, apricot and cherry trees depending on the variety and tree crown form, t/ha, the age of trees 4-7 years, DES "Criuleni"

Variety	Crown form	Number of branches, pieces	Years				Sum	Average
			2008	2009	2010	2011		
Plum trees								
Kabardinskaia Ranniaia	Mixed pyramid (witness)		0.75	11.75	12.98	8.37	33.85	8.46
	Improved bush	3	2.29	10.19	22.08	16.69	51.25	12.81
	Improved bush	4	2.85	14.04	25.76	18.93	61.58	15.40
	Improved bush	5	3.41	17.94	25.87	20.28	67.50	16.88
Stanley	Mixed pyramid (witness)		0.64	11.17	13.74	10.52	36.07	9.02
	Improved bush	3	1.82	13.92	22.56	18.96	57.26	14.32
	Improved bush	4	2.62	19.65	24.96	20.63	67.86	16.97
	Improved bush	5	3.48	21.71	24.82	20.73	70.74	17.69
Apricot trees								
Bucuria	Dwarf pyramid (witness)		3.65	-	12.70	11.80	28.50	9.50
	Improved bush	4	7.48	-	15.10	22.70	45.28	15.09
	Improved bush	5	8.91	-	14.40	21.50	44.81	14.94
	Improved bush	6	8.13	-	17.10	19.60	44.83	14.94
Krasno-shchekiy	Dwarf pyramid (witness)		2.66	-	17.60	16.30	36.56	12.19
	Improved bush	4	7.10	-	23.80	27.50	58.40	19.47
	Improved bush	5	7.63	-	21.10	26.20	54.93	18.31
	Improved bush	6	7.92	-	23.80	21.40	53.12	17.71
Cherry trees								
Uifehertoi Fiurtosi	Mixed pyramid (witness)		0.37	2.87	3.06	8.74	15.04	3.76
	Improved bush	3	0.27	2.54	5.82	16.81	25.44	6.36
	Improved bush	4	0.35	3.26	6.08	17.63	27.32	6.83
	Improved bush	5	0.39	3.87	7.14	17.42	28.82	7.21
Erdi Bötarmo	Mixed pyramid (witness)		0.73	3.18	5.04	11.64	20.59	5.15
	Improved bush	3	0.17	3.01	8.46	21.30	32.94	8.24
	Improved bush	4	0.25	3.28	10.33	24.51	38.37	9.59
	Improved bush	5	0.34	4.22	10.92	23.87	39.35	9.84

In the fructification year of plum and apricot trees, the production of fruits was higher in the plantations where the trees were trained according to improved bush. For example, the plum trees of Kabardinskaia Ranniaia variety trained according to mixed pyramid recorded a yield of 0,75 t/ha while those trained according to improved bush recorded a production which was 3-4 times higher and constituted about 2.29-3.41 t/ha depending on the number of branches.

The cherry trees recorded a smaller production of fruits on a unit of surface, regardless the variety.

In the next fructification years the production of fruits obtained from trees, regardless the species or variety was higher in the plantations where the trees were trained according to improved bush. In 2004, for example, the plantation of Kabardinskaia Ranniaia plum variety, where the trees were trained according to mixed pyramid recorded a production of fruits of 8.37 t/ha while those trained according to improved bush constituted about 16.69 up to 20.28

t/ha depending on the number of branches. As a result, the sum or average of fruit production during the studied years for all species was higher for the trees trained according to improved bush.

Fruit yield on a unit of surface varied depending on the species and variety. The highest production of fruits in the fructification years for all studied species and varieties was obtained in the plantations where the trees were trained according to improved bush type of tree crown.

Fruit yield reached its maximum values in the plum and cherry plantations where the trees were trained according to improved bush with 4 and 5 branches and in the apricot plantations where the trees were trained according to improved bush with 4 branches.

Pruning the stone species of trees according to improved bush contributed to the increase of fruit production on a unit of surface compared with the plantations where the trees were trained according to the existing recommendations.

In the plum and cherry plantations the best results were obtained when the crown was formed of 5 branches and in apricot plantations when the crown was formed of 4 branches.

CONCLUSIONS

In order to increase the fruit yield and efficiency of fruit production, the plum, apricot and cherry trees of middle and low vigor, planted at a distance of 5×2 m were trained according to improved bush type of tree crown.

Improved bush type of tree crown of plum and cherry trees was formed of 5 branches and that of apricot trees was formed of 4 branches.

When pruning for fructification the trees trained according to improved bush, the semi-skeletal branches of apricot and cherry trees should be replaced with the 4-year-cycle and those of plum trees with the 4 or 5-year-cycle.

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