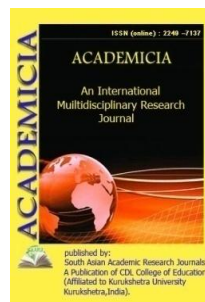




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**INFLUENCE OF ROOT GROWTH FORCE ON MORPHOLOGICAL INDICATORS OF DEVELOPMENT OF ABOVE-GROUND PART OF SPUR-GROWING VARIETIES OF APPLE**

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**ABSTRACT**

*The scientific article provides experimental material devoted to the study of morphological signs of development of apple rootstocks of various strengths and grafted apple varieties of the "spur" type on them. The study was carried out at the central experimental base of the Research Institute of Horticulture, Viticulture and Winemaking named after M.M. Mirzaev in 2015-2020. The objects of the study were: seed stock of Sievers apple tree, vegetatively propagated low-growing stocks MM 106 and M 9, as well as spur apple varieties Starking Delicious, Starkrimson, Redspur Delicious, Velspur, Hordispur, Vinespur, Golden Delicious, Goldspur Ispur, Yesspur, Yesspur. The trees in the garden were placed according to 5x4, 5x3 and 5x2 meters. In each variant, according to the replicates of the experiment, five trees were counted. During the growing season, the development of trees was controlled by the following phenological observations and biometric counts: the number of formed shoots of the current year in the crown, their average length, height, diameter and volume of the crown. Studies have shown that the most developed trees are formed when the seedlings of the Sievers apple tree are used as a rootstock. Moreover, higher rates among apple varieties of the "spur" type are observed in the spur varieties of the Golden Delicious clone.*

**KEYWORDS:** *Apple Tree, Variety, Rootstock, Spur, Growth, Development, Shoot, Height, Volume, Diameter, Crown.*

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## INTRODUCTION

In Uzbekistan, the apple tree is one of the leading industrial species. The total area of the culture is 280 thousand hectares. Of these, the area of orchards on seed vigorous rootstocks is 226 thousand/ha with an average yield of 16 tons/ha. The area of orchards grown on weak vegetative propagated rootstocks is 54 thousand/ha, with a yield of 22 t/ha.

The areas of apple trees that exist at the present time, a set of varieties and productivity do not meet the economic criteria of the industry, since they mainly satisfy the internal needs of the population. However, in order to increase the profitability of crop production, new scientific research is required to improve the varietal structure, grow plants on low-growing rootstocks, optimize variety-rootstock combinations, planting density, crown shapes and other elements of agricultural technology (1,2,3,4).

Naturally, at present, there is an interest in apple varieties of the "spur" type, which differ from the usual varieties by the natural weak growth of the aboveground part, the pyramidal crown, the formation of a large number of generative branches of the ringlet type on the shoots already in the first year of vegetation. With good agrotechnical care, spura apple varieties provide high and stable yields annually, with high fruit quality. For the active introduction of these varieties into production, it is necessary to carry out additional scientific research on the selection for them of the optimal combinations of variety-rootstock, planting density, taking into account the soil and climatic conditions of the fruit-growing regions of the republic.

## RESEARCH METHODOLOGY

The study was carried out in 2015-2020 at the experimental production base of the Research Institute of Horticulture, Viticulture and Winemaking named after V.I. M.M. Mirzaeva.

The experiment was made with 11 spur apple varieties. In each variant of the experiment, five trees were used as account. The experiment was repeated four times. Sivers apple tree (control) and vegetatively propagated rootstocks MM106 and M9 were used as rootstocks. The scheme of planting trees 5x5, 5x4 and 5x3 meters.

During the growing season of trees in the garden, the following phenological observations and biometric records were carried out: the date of the beginning and mass blooming of buds and flowering, the duration of these phases, the number of shoots of the current year, the height of the trees, the diameter of the trunk, the volume of the crown, foliage and other signs of tree development.

## RESEARCH RESULTS

Phenological observations and biometric records of the development of spur apple varieties grafted onto a vigorous seed stock of the Sievers apple tree shown in Table 1 show that this stock in a certain way affects the morphological parameters of the development of the main structural parts of the crown. In particular, among the spurious red-fruited apple varieties of the Starking Delicious clone we used, the varieties Redspur Delicious and Starking Delicious are

distinguished by intensive formation in the crown of six-year-old trees of the current year, respectively, 149 and 192 pcs/tree. For other cultivars, this indicator was 86-98 pcs/tree, that is, 1,4-1,5 times less.

The average growth length of these shoots varied in the range of 32,3–36,7 cm, that is, it did not differ significantly.

There were some differences in tree height and crown width. The spurs of varieties Redspur Delicious and Starking Delicious (control), in which this physical indicator was 3,64-3,55 meters, stood out with the greatest growth on the Sievers apple tree rootstock. The same varieties of apple trees had high rates of development of the diameter and volume of the crown 3,69-3,81 meters and 13,09-13,96 m<sup>3</sup>/tree.

The spur apple varieties such as Velspur and Hardispur have the lowest physical indicators of development of the aboveground part of plants. These apple varieties, in comparison with the rest, formed a crown 1,4 times smaller in comparison with the rest of the red-fruited spurs of the Staring Delicious clone.

The development of the crown in yellow-fruited spuric apple varieties on a seed vigorous apple stock had certain physiological differences from the red-fruited. In particular, their shoot-forming ability in the crown, in comparison with the red-fruited clones of the Starking Delicious variety, was 1,4-2,1 times higher and averaged 183 pieces per individual tree. According to the variants of the experiment, the length of these shoots reached 32,9-36,3 cm. Of the studied varieties of spurs, the variety Ellowspur was distinguished by the smallest length of shoots – 27,7 cm.

The tallest trees on the Sievers apple tree rootstock were formed by the varieties Golden Delicious and Starkspur - from 3,60 to 3,73 meters, the weaker varieties Ellowspur and Auwelspur - up to 3,09 meters. These varieties of apple spurs had a diameter and crown volume of 1,2-1,5 times less than varieties Starkspoor and Golden Delicious.

From the research carried out on the cultivation of spur apple varieties on a vigorous seed rootstock of the Sievers apple tree, it is clear that it is most realistic to grow on this rootstock: from red-fruited varieties - Redspur Delicious, Starking Delicious, from yellow-fruited - Starkspur and Golden Delicious, since the crown diameter of trees reaches 3,81 and 3,98 meters, that is, practically occupies the space between plants in a row.

**TABLE 1 MORPHOLOGICAL DEVELOPMENT OF THE CROWN OF SPUR APPLE VARIETIES AT THE AGE OF SIX, 2015-2020.**

Variety	Annual shoots		Development of the crown of a tree		
	quantity, pcs/tree	average length, cm	height, m.	Diameter, m.	Volume, m <sup>3</sup> .
Starking Delicious clones					
Staring Delicious (control)	122	36,7	3,55	3,69	13,09
Velspur	86	30,3	2,91	3,18	9,25

Hardispur	88	32,3	3,05	3,29	10,03
Starkrimson	98	35,3	3,25	3,40	11,05
Weinspur	96	32,3	3,15	3,32	10,45
Redspur Delicious	149	38,4	3,64	3,81	13,86
NSR <sub>0,5</sub>	2,0	2,3	0,07	0,08	0,81
Golden Delicious clones					
Golden Delicious (control)	184	34,2	3,60	3,82	13,75
Yellowspur	198	27,7	3,03	3,24	9,81
Goldspur	183	32,9	3,15	3,72	11,71
Auwelspur	166	30,1	3,09	3,35	10,35
Starkspur	187	36,3	3,73	3,98	14,84
NSR <sub>0,5</sub>	3,0	1,3	0,12	0,07	0,81

**Note:** Sivers apple tree rootstock

Tree planting scheme: 5x5 meters.

Cultivation of apple varieties with red and yellow colored fruits on a medium-sized vegetatively propagated stock MM 106 revealed a significant decrease in the overall development of the aboveground part of varietal trees. In particular, in the crown of six-year-old trees, there was a certain decrease in the number and length of shoots of the current year to the variant where the varieties were grown on the Sivers apple tree rootstock. According to the variety types of the Starking Delicious clone, the number of shoots of the current year ranged from 77-124 pcs/tree, for Golden Delicious clones - 139-179 pcs/tree. According to the average length of shoot growth, respectively, 28,17-34,56 cm and 27,0-33,0 cm. That is, the number of these physical indicators in the sixth year of development of varieties on average decreased to the stock of the Sivers apple tree by 20,5%.

The development of the main structural parts of the crown also tended to decrease. In particular, the crown height of six-year-old trees for the varieties of Starking Delicious clones was 2,52-3,83 meters, for Golden Delicious clones 2,60-2,95 meters. The crown diameter of trees and spurs of the Starking Delicious clone varied from 2,87 to 3,5 meters, of the Golden Delicious clones from 2,74 to 3,44 meters. The volume of the tree crown was 7,12-10,96 m<sup>3</sup>.

Of the tested varieties of apple spurs with red fruits, the smallest crown volume was for Velspur spurs – 7,23 m<sup>3</sup>, Hardispur – 7,62 m<sup>3</sup> and Vainspur – 7,87 m<sup>3</sup>. In yellow-fruited varieties, such were the varieties Ellowspur – 7,12 m<sup>3</sup> and Auwelspur – 7,77 m<sup>3</sup>. The clones of Redspur Delicious - Starking Delicious, Starkspur and Golden Delicious, respectively 10,96; 10,04; 10,14; 9,31 m<sup>3</sup>/wood.

It should be noted that at the age of six, spur apple varieties in terms of the crown development diameter occupied the space allotted to them in the row spacing from 68,5 to 86,0%. This indicates that the issue of optimizing the distribution schemes for spur varieties of both types of clones Starking Delicious and Golden Delicious requires further refinement by reducing the feeding area of varietal plants grown on the MM106 rootstock.

In the variant of growing spur apple varieties on the dwarf rootstock M9, as well as on the previous middle growth, the tendency to decrease the number of annual shoots, as well as their length, remained. The decrease in this morphological trait for trees grown on a strong Sievers rootstock was 37,7%, and for an average MM106-17,7%.

The physical indicators of the development of the main structural parts of the crown (height, diameter, volume of the crown) also had the same correlation dependence. When used for spur apple varieties with red-colored fruits of the rootstock MM 106, the height of the trees, the diameter and volume of the crown were respectively 2,38-2,90 meters, 2,12-2,95 meters and 5,68-7,56 m<sup>3</sup>/wood. That is, the overall decrease in the development of trees of this type of apple tree decreased to plants grown on a strong seed stock of Sievers in height by 20%, crown diameter by 26,5%, crown volume - by 41,3%. The decrease in these physical characteristics to the stock of the Sievers apple tree in yellow-fruited spur varieties was 37,4, respectively; 22,4 and 38,2% (Table 2).

**TABLE 2 MORPHOLOGICAL DEVELOPMENT OF THE CROWN OF SPUR APPLE VARIETIES AT THE AGE OF SIX, 2015-2020.**

Variety	Annual shoots		Development of the crown of a tree		
	quantity, pcs/tree	average length, cm	height, m.	diameter, m.	volume, m <sup>3</sup> .
Starking Delicious clones					
Staring Delicious (control)	92	29,43	2,92	3,44	10,04
Velspur	77	29,07	2,52	2,87	7,23
Hardispur	79	28,17	2,56	2,98	7,62
Starkrimson	86	29,07	2,54	3,10	7,87
Weinspur	88	29,07	2,83	3,26	9,22
Redspur Delicious	124	34,56	3,09	3,50	10,96
NSR <sub>0,5</sub>	3,1	0,1	0,7	0,2	0,15
Golden Delicious clones					
Golden Delicious (control)	169	30,1	2,91	3,20	9,31
Yellowspur	179	27,0	2,60	2,74	7,12
Goldspur	139	28,5	2,72	2,86	7,77
Auwelspur	164	29,8	2,86	3,05	8,58
Starkspur	179	33,0	2,95	3,44	10,14
NSR <sub>0,5</sub>	4,0	1,4	0,04	0,15	0,12

**Note:** stock MM 106

Tree planting scheme: 5x4 meters.

Of the varieties of apple spurs with red-colored fruits grown on the M 9 dwarf rootstock used, the varieties Velspur, Hardispur and Vainspur were the smallest and with a compact crown. In these varieties, the overall decrease in crown development of six-year-old trees, in comparison with those grown on seed vigorous, the Sievers apple-tree rootstock was 19,3% in height of the central conductor, 43,4% in crown diameter, and 45,6% in crown volume. In yellow-fruited apple spurs on the same rootstock, these characteristics were 21,8; 25,4 and 41,6% (Table 3).

**TABLE 3 MORPHOLOGICAL DEVELOPMENT OF THE CROWN OF SPUR APPLE VARIETIES AT THE AGE OF SIX, 2015-2020.**

Variety	Annual shoots		Development of the crown of a tree		
	quantity, pcs/tree	average length, cm	height, m.	diameter, m.	volume, m <sup>3</sup> .
<b>Starking Delicious clones</b>					
Staring Delicious (control)	86	27,7	2,76	2,74	7,56
Velspur	73	24,4	2,38	2,12	5,04
Hardispur	75	25,6	2,42	2,35	5,68
Starkrimson	81	27,0	2,50	2,49	6,22
Weinspur	83	29,8	2,67	2,58	6,88
Redspur Delicious	126	30,6	2,90	2,95	8,41
NSR <sub>0,5</sub>					
<b>Golden Delicious clones</b>					
Golden Delicious (control)	159	28,5	2,79	3,07	8,56
Yellowspur	131	24,5	2,37	2,42	5,73
Goldspur	140	26,6	2,55	2,59	6,60
Auwelspur	155	27,2	2,69	2,79	7,50
Starkspur	469	29,4	2,82	3,21	9,05
NSR <sub>0,5</sub>	8,0	1,2	0,12	0,11	0,43

**Note:** stock M9

Tree planting scheme: 5x3 meters.

## CONCLUSIONS

1. Of the investigated spur apple varieties, the Golden Delicious clone, grown on the strong seed stock of Sievers, Yellowspur and Starkspur have the highest shoot-forming ability in the productive age period. They are able to form in the crown of trees during the annual development cycle from 183 to 198 pieces of shoots. In the spur varieties of the Starking Delicious apple clone, these include Weinspur and Starkrimson.

2. When growing spur apple varieties on a medium-sized stock MM106 and a dwarf M9, the shoot-forming capacity of the crown of trees and the length of the shoots growth during the

growing season is reduced to those grown on the Sivers stock by 1,75-2,0 times and is, respectively, 73-75 pcs / tree and 24,4-29,8 cm. This makes it possible to grow these spurious varieties with a thickened layout.

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