



TECHNICAL EFFICIENCY OF APPLICATION OF GROWTH REGULATOR IN THE PRODUCTION AND STORAGE OF APPLES

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ABSTRACT

The paper presents the results of study of effect of treatment of fruit trees with the growth-regulating product Mival-Agro which contributed to increase in productivity of all the studied cultivars, to higher accumulation of sugars and vitamins that provided reduction of losses when storing of apples caused by physiological and microbiological diseases of fruits, exerted positive effect in increasing mean weight of fruits of all cultivars under study, and resulted in considerable increase in yield of fruits with high marketable properties and decrease in microbial population of microorganisms on the surface of fruits during the storing period. The quantity of microorganisms on the surface of apples was assessed prior to and at the end of storing period. The data received can be used when development of new methods of storing apples.

Keywords: apples, productivity, quality, microbial population, storing, growth-regulating product mival-agro.

INTRODUCTION

Currently, the population of the Russian Federation meets with the severe shortage of fresh fruits and berries which are of a great importance and necessary sources of various vitamins, mineral substances and other biologically active compounds for the complete functioning of an organism [3, 5].

It has been proved and scientifically grounded that the yearly rates of consumption of fruits and berries in our country is between 90 and 100 kg. However, the actual amount of fruits and berries differs considerably from the yearly rates and is 53 kg including the imported products [2, 13].

Apples are of a leading position among the fruits in providing the population with the products of horticulture.

Apples are the most popular fruit species. That is why it is so important to use agrarian methods that provide the increase in productivity and eating characteristics of such a valuable species [5, 14].

One of the said methods is the treatment with the growth-regulating products.

The growth-regulating products are used in horticulture as the means for intensification of growth and development of plants, rooting of cuttings, by trees replanting, for increase in productivity of a number of species, for exfoliation, growth suppression, reduction of pre-harvest drop, thinning of flowers and seed buds, etc. [7, 9, 10].

The treatment with growth-regulating products results in increase in productivity of apple-trees which is maximum when sufficient water regime.

The main characteristic of the Low Volga region is the heavy arid climate. This factor conditions the formation of unfavourable conditions for growth and development of agricultural plants. Thus, the scientifically grounded approach to the organization of watering of fruit species is of a great importance especially in conditions of

insufficient and changing moistening. The sufficiency of soil moisture predetermines both growth and normal fruit bearing of plants, and resistance to winter and low temperatures.

The species assortment of fruit plantings is a very important pattern. It should correspond to the demands of modern technologies of their arrangement and to consumers' requirements and to provide the maximum economical effectiveness.

Thus, it is necessary to produce both conventional, tasty and healthy fruits with sufficient content of valuable compounds which condition eating and treating value of the products and with high antioxidant activity. The research is being consistently developed in the said field to determine the fruits of various species with the high content of biologically active substances: vitamins, pectin, and polyphenols.

Meeting the requirements of the population in high quality foodstuff of vegetable origin is one of the most important aspects of modern science and industry. The international institutions consider the microbiological damage of foodstuff of vegetable origin to be one of the factors that reduce foodstuff reserves and as a causative of various diseases of the population [7, 11].

Due to the introduction of new methods and improvement of technological processes many fruits and vegetables show longer storing period with no reduction of their marketable characteristics. Conservation of fruit and vegetable products, especially fresh ones, is a specific, polyfactorial and complicated problem determined by the different lifetime of fruits and vegetables, high population of affecting fungi, yeasts, and bacteria, as well as by the dynamism of living organisms in spatial and timing dimensions. There are distinctive mutual relations between fruits, vegetables, and microorganisms that acutely change depending on multiple factors, such as biological, agricultural, industrial, etc. [6, 8, 12].



Various methods of conservation of fruit and vegetable products are known. However, all of them are based on the use of factors of various origin which allow specific regulating of microbiological processes when treatment, processing and storing of such a valuable foodstuff.

The problem of long-term storing of fruits is one of the most important problems as the losses in their weight and decreasing quality from microbial damage might be considerable and might in turn result in economic damage and harm consumers' health [4, 5].

To conserve effectively the fruit and vegetable products one should know the qualitative and quantitative content of microbial population of the products, containers, packing materials, industrial rooms; the regularities of propagation of fungi, yeasts, and bacteria affecting the products; urgent and perspective methods for control of their number and living activity; causative changes in response reactions of microorganisms and the products themselves to the methods used, as well as the influence of the factors of physical and chemical origin on microbial associations, marketable characteristics, storing period, and losses in products weight [1, 12, 14].

On the basis of the scientific analytical survey of literature references we have developed the concept of «The system of agro technological measures for arrangement of fruit plantings for production of high quality fruits with the longer storing period».

The purpose of our research is the assessment of the efficiency of the use of growth-regulating product Mival-Agro for increase in productivity, marketable, and eating characteristics of fruit cultivars when optimal regimes of irrigation that provide the directed regulation of microbiological processes by the treatment, processing, and storing of the said valuable foodstuff.

METHODS AND MATERIALS

The research was developed in conditions of the husbandry «Zavety Lenina» («Lenin's precepts») in the Oktyabr'sky area of the Volgograd region. During the years 2014-2016 we conducted research aimed on determining the regulations of the effect of the growth-regulator Mival-Agro on the qualitative and quantitative population of microbial association in fruit products. In 2002 in the said husbandry the garden was laid with middle-grown clone stock 54-118 with the planting intervals of 6 x 3 m and density of 555 pcs per ha. The research was conducted with regionalized and promising varieties of the Low Volga region: autumn ripening cultivar Lord Lambourne and winter ripening cultivar Gala. The treatment of apple trees with the growth-regulators was conducted according to the instructions of the producer. The trees were sprayed twice with the fresh solution of the product Mival-Agro with the concentration of 0.02 g/l in the evening time when dry still weather with knapsack sprayer in the phases of «loose bud» and «sepalum closure». The rate of the consumption of the solution: 800 l per ha 1.4 l per 1 tree.

RESULTS OF RESEARCH

The use of the growth-regulator Mival-Agro resulted in increase in marketable quality of fruits of all cultivars by 31.0 % for the cultivar Lord Lambourne and by 30.0 % for the cultivar Gala. The increase in productivity of Lord Lambourne reached 7.1 kg/1 tree that for Gala equaled 8.5 kg in comparison to the plantings not treated with the growth-regulator (Table-1).

The chemical composition predetermines the valuable characteristics of fruit and vegetable products, their quality, storing period, and losses in weight.

One knows that the increased content of such a characteristic as acidity reduces the value of apples and influences negatively the technological indicators by processing.

Table-1. Effectiveness of growth-regulator on the productivity of apple trees (average for years 2014-2016).

Tested varieties	Research variant	Mean fruit weight, g	Mean fruit diameter, mm	Fruits marketability, %		Productivity, kg/1 tree
				primary and 1 st quality	2nd and 3d quality	
Lord Lambourne	Control	144,7	68,6	55,0	45,0	37,4
	Mival-Agro, powdered crystals	155,8	69,1	86,0	14,0	44,5
HCP ₀₅		4,4	1,7			5,0
Gala	Control	135,3	65,6	57,0	43,0	38,8
	Mival-Agro, powdered crystals	144,7	66,2	87,0	13,0	47,3
HCP ₀₅		3,9	1,6			5,6

The data of the Table-2 show that the treatment with the growth-regulator contributes to the decrease of the given characteristics for all the tested cultivars. The better eating and nutritive qualitative characteristics of apples were caused by the higher values of the total of

sugars. In our research the growth-regulator conditioned the increased accumulation of sugar by 0.7 % for the cultivar Lord Lambourne and by 1.2 % for the cultivar Gala, in comparison to the control.



The characteristics of the chemical composition and the features of the fruit and vegetable products should be considered when the storing, in the process of handling and processing, as well as when the development of the nutritious rations. There are such conditions and regimes worked out that provide the minimum changes in the chemical composition and minimum reduction in value and marketability of fruit and vegetable products.

The trend of increasing losses of biomass of fruit and vegetable products caused by microorganisms is

highly recognized in the whole world. The losses in biomass caused by microorganisms differ a lot depending on the botanic species of the fruit and vegetable products (percentage to the total mass, g): apples - 11.14; pears - 17.6; apricots - 8.9; peaches - 13.2; berries - 24.6; beet - 14.5; potatoes - 12.3; carrots - 17.1. During definite years they vary meanly from 6.2 to 23.2 % while the natural loss in weight is estimated by lower values.

Table-2. Qualitative characteristics of apples by the use of the growth-regulator (average for years 2014-2016).

Tested varieties	Research variant	Dry matter, %	Total sugars, %	Acidity, %	Vitamin C, mg/100g
Lord Lambourne	Control	14,7	10,4	0,53	9,3
	Mival-Agro, powdered crystals	15,7	11,1	0,45	10,6
	HCP ₀₅	0,6	0,5	0,2	0,9
Gala	Control	12,5	8,9	0,40	5,0
	Mival-Agro, powdered crystals	13,6	10,1	0,37	6,8
	HCP ₀₅	1,2	1,3	0,1	1,1

When storing products before their processing and selling fresh the following reasons cause increasing losses: early and mechanized harvesting; long-term transportation when positive temperatures and without packing (bulk loading); storing of consignments of varied species, sorts, and products; presence of products with mechanical and biological injuries; no good presence of products; break of technologies of processing and selling; non-compliance with the priority of processing and selling of products; presence of wastes of microbiological origin in the store rooms; high microorganisms population in tare and packing materials; unsatisfactory sanative state of the inventory, equipment, production space, and working clothes of the staff.

To gain effective reduction of losses in biomass of fruit products the integrated measures should be taken at the same time in the sites of growing and harvesting when their transportation, selling, storing, and processing.

The main measure and method for control of losses in fruit products at the different stages of their movement to the consumer is the treatment of the products with the growth-regulator Mival-Agro. The component of the said product articles triethanolammonium acid salt stabilizes the state of membranes and increases the content of vitamins A and E in them, increases the plants' resistance to unfavourable environmental factors and diseases, improves the storability of the products (Table-3).

Table-3. Storability and marketable quality of apples of Gala cultivar when use of the growth-regulator, after 6-months storing (average for years 2014-2016).

Research variant	Weight loss, %	Marketable fruits, %	Wastes, %
Control	7,4	78,8	13,8
Mival-Agro, powdered crystals	6,7	88,6	4,7
HCP ₀₅	0,9	8,2	

The wastes of fruits at the end of storing period were caused by microbiological and physiological diseases that started in the garden or in the storing rooms. The treatment of fruits with the growth-regulator Mival-Agro resulted in decrease of losses when storing during 6 months by 9.1 % that provided increase in output of marketable fruits up to 88.6 %.

There are various types of microorganisms inhabiting the surface of fruit and vegetable products.

They include both typical and accidental types of microorganisms brought with the wind, atmospheric precipitations, by insects, birds, from soil by rodents, with inventory and equipment, tare, packing materials, transportation devices and other objects. There are saprophytic, phytopathogenic, and pathogenic microorganisms representing the surface microflora of fruit and vegetable products that effect humans and animals.



The characteristics of quantitative and qualitative population of surface microflora of fruit and vegetable products is of a great theoretical and practical importance as they are a basis to development of measures to control losses of products and effective means that would provide better quality and safety of the healthy products, as well as the development of optimum technological regimes of processing, handling, and storing. A considerable damage is caused by the microorganisms that spoil fresh fruit products during the processes of agricultural production, transporting, storing, processing, and selling.

The greater number of microorganisms on the surface of the products, the more the speed and the amount of spoiled products, the higher the threat of damage of prepared food and canned goods made of such products. Nevertheless, the quantitative population of fungi, yeasts, bacteria and

sanitary-representative microorganisms on the surface of processed and stored fruit and vegetable products is not studied completely. The authors' research on fruit and vegetable products has determined the comparative numeric correlation of fungi, yeasts, bacteria, and bacteria of the group of Escherichia coli (E. coli) on the surface of apples of the studied cultivars.

The surface of apples displays the minimum quantity of microorganisms in comparison to the other products. It is explained by the fact that there is a wax coating on their surface that impedes microorganisms' nutrition.

The Table-4 presents the quantitative and qualitative microbial population on the surface of apples of Gala cultivar.

Table-4. Microbiological characteristics of fruit products at the moment of start of selling, processing, and storing (average for years 2014-2016)

Preceding practices	Number of microorganisms, CFU/g				
	fungi	yeasts	bacteria		
			mesophilic	acidic	E. coli
Control	31	2,5*10 ²	1,9*10 ²	26	0
Mival-Agro, powdered crystals	18	1,1*10 ²	1,5*10 ²	11	0

The speed of propagation of fungi, yeasts, and bacteria on fruit products is determined by species characteristics of microorganisms and the products, temperature, moisture, and gas composition in the storage rooms. The mechanic and biologic damages of different type contribute to infection of juicy vegetative tissue, increase in number of microorganisms, and losses in weight of products. The damage of surface of fruit and

vegetable products may be caused by careless harvesting and handling of yield, disarrangement of temperature and moisture regimes (freezing, drying up, etc.), tare, wooden packing materials, as well as birds, rodents, insects.

Prior to the contact of fruits with wood-wool and the tare the population of fungi, yeasts, and bacteria on their surface is lower than after the contact (Table-5).

Table-5. Microbiological characteristics of apples of pomological cultivars prior and after the contact with wood-wool (average for the years 2014-2016).

Preceding practices	Variant	Number of microorganisms, CFU/g			
		fungi	yeasts	bacteria	E. coli
Control	Prior to the contact with wood-wool	2	3	45	0
	After the contact with wood-wool	74	2,1*10 ²	2,0*10 ²	1
Mival-Agro, powered crystals	Prior to the contact with wood-wool	1	1	19	0
	After the contact with wood-wool	56	1,9*10 ²	1,7*10 ²	0

After the packing of apples with wood-wool the population of microorganisms on their surface increased considerably. In some cases the single cells of E. coli were visualized on the surface of fruits after the contact with wood-wool.

During the storing of apples of the studied cultivars (prior to the processing and selling fresh) the

population of fungi, yeasts, and bacteria on their surface was increasing. The said biological process was going on with no dependence on temperature conditions and initial population of microorganisms on the surface of products. The Table-6 presents the data on changing population of fungi, yeasts, and bacteria on the surface of apples of Gala cultivar.



Table-6. Dynamics of changing of number of microorganisms on the surface of apples depending on storing period when temperature of 2 °C (average for years 2014-2016).

Preceding practices	Storing period, months	Number of microorganisms, CFU/g		
		fungi	yeasts	bacteria
Control	Start of storing (control)	36	58	3,3*10 ²
	2	79	81	6,8*10 ³
	3	1,1*10 ²	6,5*10 ²	7,2*10 ⁴
	4	2,82*10 ²	8,9*10 ²	2,83*10 ⁴
Mival-Agro, powered crystals	Start of storing (control))	27	49	2,1*10 ²
	2	43	53	4,5*10 ²
	3	97	1,08*10 ²	1,2*10 ³
	4	1,6*10 ²	1,17*10 ²	4,8*10 ³

Analyzing the data given in the Table-6 the conclusion was made that the more considerable decrease in microorganisms population on the surface of apples was noted when the treatment with the growth-regulator in the storing period in comparison to the control variant with no treatment made.

The use of organosilicon growth-regulator Mival-Agro in fruit production is an agrotechnical mean of high effectiveness in conditions of the Low Volga region that provides getting of high yields of apples with higher quality indices through increase in resistance of plants and fruits to diseases and unfavourable weather conditions (44.5 and 47.3 kg per 1 tree).

CONCLUSIONS

The results of developed research indicated that the treatment of fruit trees with the growth-regulators exerted positive influence on increasing mean weight of fruits of all studied cultivars and considerably increased the outcome of fruits of marketable grades. The growth-regulator Mival-Agro conditioned the increase in yield of all studied cultivars. The treatment with Mival-Agro contributed to higher accumulation of sugars and vitamins that provided the reduction of losses by storing apples caused by physiological and microbiological diseases of fruits. The data received might be used when development of a new systems of storing apples.

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