Efficiency of liquid chelate fertilizers organomix in apple growing in the conditions of the forest zone of the KBR

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Abstract. Horticulture is a highly intensive industry that requires significant costs in the establishment and maintenance of plantations. The profitability of horticulture, which in the republic can reach up to 150%, depends on the use of a rational fertilization system, taking into account the biological characteristics of fruit and berry crops, the age of the garden, the phase of plant development, soil and weather conditions. Particularly high nutritional requirements are imposed by intensive early ripening varieties of fruit crops on tall rootstocks. In this work, we studied the effect of liquid chelated fertilizers Organomix when processing trees on the yield, commercial qualities of the fruit of the Florina apple tree in the conditions of the forest fruit zone of the Kabardino-Balkarian Republic. The most noticeable effect on increasing the yield of trees (27.4 t / ha) was exerted by the combined use of the preparations Organomix fruit and berry (0.5 l / ha), Organomix Bor (0.5 l / ha), Organostim (0.6 l / ha) in the walnut phase. The use of the preparations contributed to an increase in the productivity of the apple tree by 16.9-32.4%. Treatment of apple trees with Organomix preparations gives high economic efficiency due to the increase in the commercial quality of the fruits.

1 Introduction

The need of fruit crops for food elements cannot be satisfied without improving the technology of mineral nutrition [1]. Of particular relevance is the complex use of agrochemicals associated with traditional industrial mineral fertilizers, their combination with new and innovative forms, in particular liquid chelated fertilizers containing macro- and microelements [1,2].

In the system of fertilization of fruit crops, the role of foliar dressing with microelements increases significantly, which largely determine the qualitative characteristics of plants, their resistance to adverse environmental conditions. In this regard, much attention is paid to the choice of forms of micronutrient fertilizers, among which preference is given to chelate compounds [1,4].

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The varietal characteristics of fruit crops are the main factor determining the taste and chemical composition of the fruit. Realization of the potential of the variety is possible only with the regulation of the main elements of the modern system of growing fruit - irrigation and mineral nutrition [3].

Studies of Belarusian scientists have shown that six-fold treatment of apple trees with chelated fertilizers "KompleMet-Calcium" and "KompleMet-Calcium-extra" led to a significant increase in the amount of sugars in fruits, the content of ascorbic acid increased by 1.29 mg / 100 g [4].

The study of the effect of foliar dressing with complex fertilizers "Ferticare 1", "Ferticare 2", "Ferticare 3", "ferticarestarter" and "Power" on the quality of fruits in apple trees in superintensive orchards of Romania revealed an increase in the content of glucose, fructose, pectin substances, organic acids, vitamin C [5].

Lithuanian scientists have confirmed the reports of scientists from different countries that the use of foliar dressing with calcium fertilizers increases the quality of fruits, reduces the attack on fruits by bitter pitting and does not affect the hardness of the pulp and the content of soluble solids [8].

The analysis of the studies of domestic and foreign scientists allows us to conclude that foliar feeding with microelements, namely, their chelated forms, are becoming increasingly important since they significantly enhance the redox processes in the plant organism [1,6,5,7]. The use of such fertilizers can significantly increase crop yields and improve product quality.

Purpose of the study: to study the peculiarities of the reaction of trees of the Florina variety to the actions of Organomix preparations in the forest fruit zone of the Kabardino-Balkarian Republic.

2 Experimental conditions and research methods

The research was carried out on the Florina apple variety (France). The variety was included in 2000 in the State Register of Russia for the North Caucasus region. Winter variety. The height of the tree is average - up to 3.5 meters. Fruits are tied on annual growths and on ringlets. The experiment included fruiting trees of an intensive unsupported orchard laid in 2012 in the forest fruit zone of the Kabardino-Balkarian Republic, at an altitude of 550-650 meters above sea level. The planting scheme is 5 - 2.4 m, which is 833 der / ha, stock MM106. The crowns are formed according to the "Russian spindle" system. Row spacing system - sodding through the row spacing. Experiments were placed in the garden by randomization. In each variant, 10 trees were treated. The soils of the experimental garden are dark gray forest residual calcareous soils. The thickness of the humus profile (A + B) in the characterized soil is on average 65 cm, the reaction of the soil solution is weakly acidic (pH = 5.8), the humus content is low (3.2-4.7%).

Table 1. Experience scheme:

№ option	Processing time	Name of drugs, dosage
1	Control	
2	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha
		Organomix Bor 0.5 l / ha
	After flowering, in the phase of hazel or walnut	Organomix fruit and berry 0.5 l / ha
		Organomix Bor 0.5 l / ha
3	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha
		Organomix Bor 0.5 l / ha

	After flowering, in the phase of hazel or walnut	Organostim 0.6 l / ha
		Organomix fruit and berry 0.5 l / ha
		Organomix Bor 0.5 l / ha
		Organostim 0.6 l / ha
4	Before the phase of pink bud	Organomix fruit and berry 0.5 l / ha
		Organomix Bor 0.5 l / ha
		Organomix Zinc 0.5 l / ha
		Organomix Iron 1.0 l / ha
	After flowering, in the phase of hazel or walnut	Organomix fruit and berry 0.5 l / ha
		Organomix Bor 0.5 l / ha
		Organomix Zinc 0.5 l / ha
		Organomix Iron 1.0 l / ha

In the year of the study (2019), the following was determined: the structure of the crown; total shoot growth; average shoot length; number of growth shoots and annelids per 1m of skeletal branch. The number of fruits on the tree was counted during the period of their picking. The average fruit weight was determined by weighing 100 fruits taken from each counting tree. The yield was recorded from each experimental tree, and then the yield was recalculated in tons per hectare.

3 Research results

The development of an agrotechnical system that allows balancing the processes of vegetative and generative development in fruit plants and, in particular, on the most important fruit crop - the apple tree, is of great importance. In solving this problem, more importance is given to chemical substances with physiological activity [5,6].

Liquid chelated fertilizers Organomix already in the first year of use had a certain positive effect on the structure of apple tree branches. The greatest result was achieved in the variant of combined use of the preparations Organomix fruit and berry (0.5 l / ha), Organomix Bor (0.5 l / ha), Organostim (0.6 l / ha) until the rose bud phase. The ratio of generative to growth formations ("K") increased by 84.4% in comparison with the control (Table 1). The use of these preparations in the phase of hazel or walnut also increased the number of generative formations by 40.6% compared to the control, but the ratio of generative formations to growth during this period of treatment decreased by 1.3 times in comparison with the period of treatment before the phase of rose bud. The number of growth shoots when treated with Organomix fruit and berry (0.5 l / ha), Organomix Bor (0.5 l / ha), Organostim (0.6 l / ha) in the walnut phase increased by 1.9 pcs. , and the number of generative formations decreased by 7.1 pcs. compared to treatment with these preparations to the rosebud phase. Treatment of apple trees of the Florina variety with Organomix preparations had a positive effect on the structure of branches and increased the number of generative formations by 1.32-1.99 times as compared to the control. In all variants of the experiment, the ratio of generative formations to growth formations ("K") was higher in the period of processing before the rosebud phase.

Table 2. The structure of a branch of an apple-tree variety Florina, processed drugs (number of organs per 1 m of the skeletal branch, pcs. 2019)

Variant No	Processing time	Name drugs, dosages	Number of increments in the form of growth shoots (pcs.)	overgrowing twigs in the form of rings, spear, twigs (pcs.)	"K" - ratio generative entities to growth	"K" in% from control (2019)
1	Control, b/o		10,5	33,2	3,2	100
2	Until the phase of a pink bud	Organomix fruit berry 0.5 l / ha	11,3	52,0	4,6	143,8
		Organomix Boron 0.5 l / ha				
	After flowering, in the phase of hazel or walnut	Organomix fruit berry 0.5 l / ha	12,8	44,1	3,9	121,9
		Organomix Boron 0.5 l / ha				
3	Until the phase of pink bud	Organomix fruit berry 0.5 l / ha	11,2	66,1	5,9	184,4
		Organomix Boron 0.5 l / ha				
		Organostim 0.6 l / ha				
	After flowering, in the phase of hazel or walnut	Organomix fruit berry 0.5 l / ha	13,1	59,0	4,5	140,6
		Organomix Boron 0.5 l / ha				
		Organostim 0.6 l / ha				
4	Until the phase of pink bud	Organomix fruit-berry 0.5 l / ha	12,4	61,5	4,9	153,1
		Organomix Boron 0.5 l / ha				
		Organomix Zinc 0.5 l / ha				
		Organomix Iron 1.0 l / ha				
	After flowering, in the phase of hazel or walnut	Organomix fruit-berry 0.5 l / ha	13,2	58,1	4,4	137,5
		Organomix Boron 0.5 l / ha				
		Organomix Zinc 0.5 l / ha				
		Organomix Iron 1.0 l / ha				

The average shoot length in all variants of the experiment was 6.5-18.6 cm more than in the control. In the climatic conditions of 2019, the combined use of the preparations Organomix fruit and berry (0.5 l / ha), Or-ganomix Bor (0.5 l / ha), Organostim (0.6 l / ha) up to the pink bud phase contributed an increase in the shoot length of the Florina apple-tree by 48.7% (Table 3).

Table 3. The average length of the shoots of the Florina apple tree in connection with the use of drugs, cm (2019)

Vari ant No.	Processing time	Name of drugs dosages	2019	%
1	Control, b / o		38,2	100,0
2	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha	47,5	124,3
		Organomix Bor 0.5 l / ha		
	After flowering, in the hazel or walnut phase	Organomix fruit and berry 0.5 l / ha	44,7	117,0
		Organomix Bor 0.5 l / ha		
3	Before the pink bud phase	Organomix fruit and berry 0.5 l / ha	56,8	148,7
		Organomix Bor 0.5 l / ha		
		Organostim 0.6 l / ha		
	After flowering, in the hazel or walnut phase	Organomix fruit and berry 0.5 l / ha	53,9	141,1
		Organomix Bor 0.5 l / ha		
		Organostim 0.6 l / ha		
4	Before the pink bud phase	Organomix fruit and berry 0.5 l / ha	48,3	126,4
		Organomix Bor 0.5 l / ha		
		Organomix Zinc 0.5 l / ha		
		Organomix Iron 1.0 l / ha		
	After flowering, in the hazel or walnut phase	Organomix fruit and berry 0.5 l / ha	47,1	123,3
		Organomix Bor 0.5 l / ha		
		Organomix Zinc 0.5 l / ha		
		Organomix Iron 1.0 l / ha		
NSR05			12,4	

The possibility of regulating various quality indicators of the generative organs of an apple tree in the process of their cultivation using foliar nutrition of trees with various macro- and microelements is shown by the results of the experiment. An increase in the percentage of useful ovary led to a significant increase in yield in all variants of the experiment. The most noticeable effect on increasing the yield of trees (27.4 t / ha) was exerted by the combined use of the preparations Organomix fruit and berry (0.5 l / ha), Organomix Bor (0.5 l / ha), Organostim (0.6 l / ha) in the walnut phase. The yield increased on this variant of the experiment by 32.4%. (Table 3). On the variant of combined use of the preparations Organomix fruit and berry 0.5 l / ha, Organomix Bor 0.5 l / ha, Organomix Zinc 0.5 l / ha, Organomix Iron 1.0 l / ha, in the walnut phase, larger fruits (146.4 g). The weight of the fetus in this variant of the experiment increased by 24.9 g in comparison with the control variant. In the variants of the experience of combined use of the preparations Organomix fruit and berry 0.5 l / ha and Organomix Bor 0.5 l / ha, the yield (24.2-24.6 t / ha) increased due to the number of fruits, since in this variant of the experiment fruits with a smaller weight (129.0-129.6 g) were formed. As a rule, in the specific climatic conditions of the mountainous zone, fruits with a lower mass are formed in the plantings than in the plantations on the plain.

All tested fertilizers had a positive effect on the commercial quality of fruits when processing trees. The use of foliar dressing with liquid chelated Organomix fertilizers increased the yield of fruits of the highest and first grades by 5-59% and 2-13%, respectively (Table 4). A significant result of improving the commercial quality of apple fruits of the Florina variety was obtained by treating trees with Organomix 0.5 l / ha, Organomix Bor 0.5 l / ha, Organomix Zinc 0.5 l / ha, Organomix Iron 1.0 l / ha in the phase of the walnut.

Table 4. Productivity of Florin apple tree when treated with Organomix preparations, t / ha (2019)

Variant No.	Processing time	Name of drugs, dosages	in 2019	% to control	Average weight fruit, g
1	Control, b / o		20,7	100	121,5
2	Until the phase of pink bud	Organomix fruiting berry 0.5 l / ha	24,2	116,9	129,0
		Organomix Bor 0.5 l / ha			
	After flowering, in the phase of hazel or walnut	Organomix fruit berry 0.5 l / ha	24,6	118,8	129,6
		Organomix Bor 0.5 l / ha			
3	Before the phase of pink bud	Organomix fruiting berry 0.5 l / ha	26,8	129,5	134,7
		Organomix Bor 0.5 l / ha			
		Organostim 0.6 l / ha			
	After flowering, in the phase of hazel or walnut	Organomix fruit berry 0.5 l / ha	27,4	132,4	138,2
		Organomix Bor 0.5 l / ha			
		Organostim 0.6 l / ha			
4	Until the phase of the pink bud	Organomix fruiting berry 0.5 l / ha	24,3	117,4	140,7
		Organomix Bor 0.5 l / ha			
		Organomix Zinc 0.5 l / ha			
		Organomix Iron 1.0 l / ha			
	After flowering, in the phase of hazel or walnut	Organomix fruit berry 0.5 l / ha	25,9	125,1	146,4
		Organomix Bor 0.5 l / ha			
		Organomix Zinc 0.5 l / ha			
		Organomix Iron, 1.0 l / ha			
	NSR05		2,3		8,3
	Experience error,%		2,7		2,6

On this variant of the experiment, the yield of fruits of the highest commercial grade was 72%, which is 59% higher than the control variant. The use of Organomix preparations significantly increased the share of 1st grade fruits in the standard part of the crop. Fruits of the third commercial grade were absent in the treatment options for trees with the preparations Organomix fruit and berry 0.5 l / ha, Organomix Bor 0.5 l / ha, Organomix Zinc 0.5 l / ha, Organomix Iron 1.0 l / ha to the pink phase bud and in the walnut phase and when treated with Organomix fruit and berry 0.5 l / ha, Organomix Bor 0.5 l / ha, Organostim 0.6 l / ha when treated in the walnut phase. In other variants of the experiment, the presence of unwanted fruits of the third commercial grade unsuitable for further effective use was less than in the control by 2-9%.

Table 5. Influence of treatments with Organomix preparations on the commercial qualities of apple fruits of the Florina variety (2019)

Variant No.	Processing time	Name of drugs, dosage	Commercial grade,%			
			highest	first	second	third
1	Control, b / o		13	45	31	11
2	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha	18	47	26	9
		Organomix Bor 0.5 l / ha				
	After flowering,	Organomix fruit and berry 0.5 l / ha	24	54	14	8

	in the phase of hazel or walnut	Organomix Bor 0.5 l / ha				
3	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha	28	45	25	2
		Organomix Bor 0.5 l / ha				
		Organostim 0.6 l / ha				
	After flowering, in the phase of hazel or walnut	Organomix fruit and berry 0.5 l / ha	34	58	8	0
		Organomix Bor 0.5 l / ha				
		Organostim 0.6 l / ha				
4	Before the phase of pink bud	Organomix fruit and berry 0.5 l / ha	53	30	17	0
		Organomix Bor 0.5 l / ha				
		Organomix Zinc 0.5 l / ha				
		Organomix Iron 1.0 l / ha				
	After flowering, in the phase of hazel or walnut	Organomix fruit and berry 0.5 l / ha	72	26	2	0
		Organomix Bor 0.5 l / ha				
		Organomix Zinc 0.5 l / ha				
		Organomix Iron 1.0 l / ha				

Determining the economic feasibility of using certain techniques is an important component of the study. The sale of apples provides a profit at a certain yield of standard fruits. Improving the commercial quality of the fruit contributes to increasing economic efficiency. Cultivating varieties that are genetically resistant to diseases such as scab can significantly increase the cost-effectiveness of horticulture as the number of tree treatments is reduced. The highest economic efficiency (profit per hectare 641.1 thousand rubles with a profitability level of 214.3%) was achieved with the combined use of the preparations Organomix 0.5 l / ha, Organomix Bor 0.5 l / ha, Organomix Zinc 0.5 l / ha, Organomix Iron 1.0 l / ha in the walnut phase (Table 6). The increase in profitability on this option is not associated with an increase in yield, but with an increase in the share of premium fruits, that is, with an increase in the commercial quality of the crop. The selling price of the highest grade apple fruits was 40 rubles / kg, the first grade was 28 rubles / kg, the second grade was 11 rubles / kg, and non-standard products (third grade) were 5 rubles / kg. The main indicator characterizing the economic efficiency of fruit production technologies is the level of profitability. The profitability in other variants of the experiment was also high (94.2-182.0%). Thus, the use of Organomix preparations on apple trees of the Florina variety in the forest zone of the KBR allows increasing the commercial quality of the fruits and thereby increasing the economic efficiency of the orchard.

Table 6. Economic efficiency of apple fruit production when applied Organomix preparations (2019)

No. variant	Processing time	Name drugs, dosage	Yield, t / ha	Cost of gross production, thousand rubles	Direct costs, thousand rubles / ha	clean income, thousand rubles / ha	Cost of 1 ton of fruit, thousand	Profitability, %
1	Control, b / o		20,7	450,3	292,4	157,9	14,1	54,0
2	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha	24,2	575,4	296,2	279,2	12,2	94,2
		Organomix Boron 0.5 l / ha						
	After flowering, in the phase of	Organomix fruit and berry 0.5 l / ha	24,6	655,5	296,6	358,9	12,1	121,0

	hazel or walnut	Organomix Boron 0.5 l / ha						
3	Until the phase of pink bud	Organomix fruit and berry 0.5 l / ha	26,8	714,1	298,0	416,1	11,1	139,6
		Organomix Boron 0.5 l / ha						
		Organostim 0.6 l / ha						
	After flowering, in the phase of hazel or walnut	Organomix fruit and berry 0.5 l / ha	27,4	841,7	298,6	543,1	10,8	182,0
		Organomix Boron 0.5 l / ha						
		Organostim 0.6 l / ha						
4	Before the phase of pink bud	Organomix fruit and berry 0.5 l / ha	24,3	764,7	297,5	467,2	12,2	157,0
		Organomix Boron 0.5 l / ha						
		Organomix Zinc 0.5 l / ha						
		Organomix Iron 1.0 l / ha						
	After flowering, in the phase of hazel or walnut	Organomix fruit and berry 0.5 l / h	25,9	940,2	299,1	641,1	11,5	214,3
		Organomix Boron 0.5 l / ha						
		Organomix Zinc 0.5 l / ha						
		Organomix Iron 1.0 l / ha						

4 Conclusions

1. The tested preparations Organomix had a positive effect on the structure of the branches of the apple-tree variety Florina in the forest fruit zone of the KBR. The greatest effect was obtained in the variant with the combined use of the preparations Organomix fruit and berry (0.5 l / ha), Organomix Bor (0.5 l / ha), Organostim (0.6 l / ha) until the phase of a rose bud. The ratio of generative formations to growth formations ("K") increased by 84.4%.
2. The most noticeable effect on increasing the yield of trees (27.4 t / ha) was exerted by the combined use of the preparations Organomix fruit and berry (0.5 l / ha), Organomix Bor (0.5 l / ha), Organostim (0.6 l / ha) in the walnut phase. The use of the preparations contributed to an increase in apple productivity by 16.9-32.4%.
3. All tested preparations had a positive effect on the commercial quality of the fruit. A significant result of improving the commercial quality of apple fruits of the Florina variety was obtained when trees were treated with Organomix 0.5 l / ha, Organomix Bor 0.5 l / ha, Organomix Zinc 0.5 l / ha, Organomix Iron 1.0 l / ha in the phase of the walnut. On this variant of the experiment, the yield of fruits of the highest commercial grade was 72%, which is 59% higher than the control variant. Treatment of apple trees with Organomix preparations gives high economic efficiency by increasing the commercial quality of the fruits.

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