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M. K. Zhumagulova[1], Z. B. Bakenova[1],
G. N. Kairova[2], T. A. Kharlamova[2], I. Roslan[3]

[1]Department of Soil Science and Agrochemistry, Faculty of Agrobiology,
Kazakh National Agrarian University, Almaty, Kazakhstan.
[2]Kazakh Research Institute of Horticulture and Viticulture, Almaty, Kazakhstan.
[3]Department of Land Management, Faculty of Agriculture, University Putra Malaysia, UPM Serdang,
Selangor, Malaysia.
E-mail: moldirzhumagulova1990@gmail.com

FRUIT QUALITY AND YIELD OF *APORT* (apple fruit) WITH APPLICATION OF FERTILIZERS AND BIOPRODUCT FROM ILI ALATAU HILLS, KAZAKHSTAN

Abstract. This article presents the harvest of *Aport* apple fruits, with emphasis on quality, yield and sustainability of soil fertility in the apple orchard on dark chestnut soils in the foothill zone of the Ili Alatau. The study noted the fertilizer application system, soil nutrition content, level of fruit harvest, soil-climatic condition and related environmental factors.

As a result, it was noted that, with daily watering practice, it gave a yield of *Aport* apple fruits at 120 kg per hectare (with the application of mineral fertilizers, $N_{110}P_{110}K_{120}$). The optimum yield of 164 kg/ha and good quality were obtained with periodic irrigation, $N_{55}P_{55}K_{60}$ mineral fertilizer in-combination of foliar treatment of bioproduct-MERS.

Keywords: apple tree, mineral fertilizers, bioproduct, productivity, fruit quality.

Introduction. One of the main tasks of agriculture is to provide food for the population, such as horticulture products, particularly apples, in sufficient quantity and good quality. The solution of this task is to develop effective agro-technical measures that support successful cultivation of fruit trees with sustainable yields.

A significant contribution to the development of horticulture, as well as to the preservation and enrichment of the gene pool of cultivated plants, were made by Kazakhstan scientists, such as Dzhangaliev A.D., Korneichik Zh.N., Kiryushchenko Z.I., Kosareva O.N., Matzhanov B.G., Korneychik O.N., Ayapov K.D., Oleichenko S.N.

Globally, apple fruit tree belongs to the genus Malus of leafy tree and shrubs kind with round sweet or sour-sweet fruits, Rosaceae family, and the Pomoideae Focke subfamilies. According to the botanical characteristics, apple trees are differentiated by the columns in the flower fused at the base, the flesh of fruits without stony cells, the flowers of the pink are rarely, almost red or white. Typical apple fruits have a peduncle which grows from developed funnel – deepening. In vegetative organs of the apple trees, the rounded type of crown is more characteristic, since skeletal branches usually develop under a more blunt corner. The root system of the apple tree, as a rule, is not a deep-rooted tree. Hence, the above stated apple culture gained high popularity due to its valuable production and biological qualities - high productivity, sufficiently high winter hardiness in comparison with other fruit breeds, great diversity in terms of maturation, suitability of varieties for various types of processing, high consumer qualities, the ability of a number of varieties for long-term storage, providing their use almost all year round [2].

Apples have high nutritional values with beneficial health effect. Ripened fruits include everything necessary for the life of the human body: easily digestible sugars, vitamins A, B, C, D, E, R, K, carotenes, organic acids, pectic substances, essential oils, tannins and colorants, amino acids, flavonoids, mineral salts and fiber. Regular consumption of apple contributes to the improvement of the body, reducing the effects of radiation, strengthening the cardiovascular and nervous systems. Apple fruits are used fresh or as dried fruits, as well as suitable for different types of processing: produce juices, making varenie, jams and compotes. The active substances of apple fruits have antiviral and antimicrobial properties, promote the removal of harmful carcinogens, heavy metal salts from the body [3].

One of the agro-technical methods is the use of fertilizers, which affects the productivity of plants, while taking into account the optimal qualitative and quantitative ratio of the basic elements of nutrition in the development of the system under the apple tree [4]. A high-grade mineral nutrition strengthens growth processes, improves the laying of generative organs, accelerates and intensifies fruiting. At the same time, the agro-chemical and economic efficiency of the application of fertilizers depends to a large extent on the observance of a scientifically grounded nutrition system that allows not only to increase the yield without deteriorating its quality, but also to preserve soil fertility in the apple orchard, plus prevent environmental pollution of the agriculture land with excessive amounts of fertilizers [5].

The development, growth and productivity of fruit trees depend on the provision of soil with nutrients, since they grow in the orchard for dozens of years and constantly absorb nutrients from the soil, then without nutrient input, their productivity declines over time. Therefore, regular replenishment of nutrients in the soil is essential. In addition to the natural soil nutrient status, the fertility of the soil can be maintained artificially through: application of organic and/or mineral fertilizers and/or biological product in-combinations. The nutrient uptake of fruit plants often occurs at two important stage - from the beginning of the spring vegetation to the growth end of shoots, second closure of shoot growth to late autumn [6-8]. In the first years of life, plants particularly require phosphorus, as it stimulates root growth and provides an increase in the aboveground mass. Phosphorus (availability) nutrition has a positive effect not only on the yield, but also on the quality of the sugar content, on the preservation of fruits, etc. Nitrogen fertilizers sharply increase the yield and for nitrogen nutrition of perennial plantations it is necessary to use organic and nitrogen fertilizers, as it will create favorable conditions for bacteria (they convert nitrogen from a form not assimilated to plants into digestible form). Potassium helps plants absorb carbon dioxide from the air and nitrogen from the soil, increases their winter hardiness and drought resistance [9].

Thus, one of the most important aspects to increase the yield of fruit crops is plants basic nutrient in optimum level, however currently limited data on fertilizers and biological products of apple plantations. Therefore, this study focus on the influence of mineral fertilizers and biological products application into apple orchard on the productivity of fruit apple under dark chestnut soils of Ili Alatau.

Materials and methods

Soil cover piedmont zone Almaty region contains the various types of soil with different mechanical composition. Soils in this region are marked with good topography-relief, irrigation, machine access, and favorable climatic-condition for the cultivation of fruit crops.

Soils in Ili Alatau were dark chestnut soil, medium-loamy in texture, has a fully developed profile, clearly differentiated into genetic horizons.

Climatic condition. The climate of the foothill zone at the southeast of Kazakhstan is extra continental, with frequent frosts and recurrent frosts in April and early May. Annual precipitation is about 500 mm. Average annual air temperature + 8,6 °C. The duration of the frost-free period averages 150 days. Amount of effective temperatures 3100–3300 °C, which is sufficient for normal growth and development of horticultural crops (table 1).

Irrigation experimental set-up. The research was conducted with 2 types of irrigation technology, as stated below:

1. The daily irrigation of the young orchard of Aport by a small rate of the total water consumption for the past day.

2. Periodic irrigation is the norm equal to the deficit of water consumption for the period before the reduction of the critical soil moisture is not lower than 70% of the lowest moisture capacity of the soil.

Table 1 – Meteorological data

Months	Average daily temperature, °C	Maximum temperature, °C	Minimum temperaturem °C	The amount of precipitation, mm
IX	20,1	31,0	8,0	18,0
X	6,0	24,0	-8,0	90,7
XI	1,1	17,0	-16,0	96,0
XII	2,6	15,0	-14,0	82,0
I	-2,3	10,5	-17,0	25,3
II	-1,5	14,0	-17,5	32,3
III	2,0	21,0	-10,0	22,1
IV	10,7	27,0	-4,5	165,3
V	18,2	32,0	2,0	160,7
VI	22,1	35,0	8,0	60,0
VII	25,6	37,0	13,5	2,5
VIII	18,2	32,0	2,0	160,7
IX	22,1	35,0	8,0	60,0

Fertilizer experimental set-up. Fertilizer study were conducted in 5 different treatment, as stated below:

1. Control (without fertilizer)
2. $N_{110}P_{110}K_{120}$
3. $N_{55}P_{55}K_{60}$
4. $N_{55}P_{55}K_{60}$ + Rososol
5. $N_{55}P_{55}K_{60}$ + MERS

Tree planting distance. *Aport* apple trees spacing were 5m (between rows) x 3m (between trees). The number of trees in the lot is 5, in the variant – 15.

Plant growth parameters of apple tree. Data collected for plant growth were focused on:

I) vegetative growth of the fruit tree (diameter of the stem, area of the leaf surface, the increment of annual shoots, counting the number of rings);

II) biological accounting of the crop

– count the number of fruits in all the registration trees in the walnut stage

– determine the average weight of the fruits for all treatment of the experiments in the period of removable maturity;

III) quality of fruit were determined based on;

–nutrients in soil and in leaves.

Accounting, observation of plants, selection of soil and plant samples were collected out according to generally accepted methods [10-12].

Results and Discussion

A study was conducted to assess the application of mineral fertilizers with/without bioproduct, influence on quality and yield of *Aport* apple fruits on dark chestnut soils under the conditions of the foothill zone of the Ili Alatau.

The aim of this work is to obtain stable and high-quality *Aport* fruit yields in a high-density orchard with a limited service life with optimization of mineral nutrition (figure).

An experiment was conducted on dark chestnut soil, medium-loamy in texture, that has a fully developed profile, clearly differentiated into genetic horizons.

Selected soil physico-chemical characteristics in Ili Alatau area. Study data indicate that in the surface (plow) layer of the soil in Ili Alatau, it contains 3.31-3.86% of humus; 0.18-0.20% of total nitrogen; 0.19-0.20% of total phosphorus. The content of available phosphorus in the plow layer is 30-40 mg/kg,

Aport apple tree in Ili Alatau

available potassium 350-390 mg/kg. The amount of the absorbed bases (cation exchange capacity) is 20-21 mg/kg 100 g of soil. The reaction of the soil solution is slightly alkaline, close to neutral (pH 7.3-7.4). The soil is weakly and moderately compacted, the bulk density is 1.1-1.2 kg/cm^3, the lowest moisture capacity is 26.6%. The soil structure is friable, weakly expressed.

Fertilizers input on apple fruit growth and yield. Fertilizers are known to influence growth, yield and to some extent the quality of apple. Fruit-bearing plants often require mineral, in various form. Organic, inorganic and biological fertilizers enrich the soil with nutrients, improve the physical properties of soil, water and air regimes which provide carbon dioxide for plant photosynthesis process. Fertilizer use in fruit trees has optimum growth promoting-effect when irrigation system (water) are also well-managed, as water transport soil-solution nutrient into tree cells.

Fruit trees yield formation is associated with nutrient availability in the soil. In harvest years with heavy fruiting, the main part of nutrients from the roots, trunk, branches and leaves are transported to the reproductive organs – flowers, ovaries and fruits, as a result the size of the leaves and the growth of shoots and roots decreases, which reduces assimilation of carbon dioxide and minerals.

Under the influence of fertilizers to soil, the agrochemical properties of the soil improve, the yield increases, the structure of the crown of apple trees improves due to the strengthening of the formation of fruit-bearing organs, and if the crown is limited, which undoubtedly should lead to a reduction in labor costs for pruning trees.

Studies have shown that under the influence of fertilizers and biological products in the apple tree, leaves chlorophyll content increase, improved optical properties, increase in the number of roots.

According to the research growth parameters, measurements and surveys have shown that the use of mineral fertilizers had an impact on the growth and development of *Aport* trees, growing, against the background of daily irrigation, and on the background of periodic watering.

The best results for the majority of *Aport* indicators were obtained in two treatments: I) application of $N_{110}P_{110}K_{120}$ + drip irrigation system, and II) foliar spraying of apple trees with MERS + $N_{55}P_{55}K_{60}$.

Number of leaves per tree was the highest daily irrigation + $N_{55}P_{55}K_{60}$ + MERS, -1899 leaves/tree compared to the control of 964 leaves/tree.

Meanwhile, with periodic irrigation + $N_{110}P_{110}K_{120}$ gave apple yield of 2192 leaves/tree, whereas, control tree without fertilizer application with only 1000 leaves/tree.

The largest area of the leaf surface of the tree was formed at the background of daily irrigation when $N_{55}P_{55}K_{60}$ was applied with foliar treatment with MERS - 4.53 m^2/tree, at the control only -2.14 m^2/tree. At the background of periodic irrigation with over area of the leaf surface, reliably isolated treatment was the $N_{110}P_{110}K_{120}$ - 6.09 m^2/tree, on the control application was 1.84 m^2/tree.

Under daily irrigation system, *Aport* trees had about average 15-152 bloom flowers/tree, whereas control tree without fertilizer application only 97 bloom flowers, with the largest number was treatment

$N_{110}P_{110}K_{120}$. Meanwhile, under periodic irrigation system, *Aport* trees had on average 14-226 bloom flowers/tree, in the control treatment had 27 bloom flowers/tree, the largest number was with mineral fertilizers and bioproduct MERS 226 bloom flowers/tree.

Meanwhile, the percentage of useful ovary variants with fertilizers ranged at the daily irrigation was between 6.2-20% (at the control 7.2%), at the periodic irrigation was between 4-23.6%; successfulness of bloom flower into fruits. Whereas, control tree without fertilizer application, the successfulness was only at 7.4%.

With the daily irrigation, the best yield was obtained by treatment $N_{110}P_{110}K_{120}$ (121 kg/ha), at 82 kg/ha in the control application without the use of fertilizers. With periodic irrigation, the highest yield (164 kg/ha) was obtained by applying $N_{55}P_{55}K_{60}$ + bioproduct MERS at 23 kg/ha at the control without fertilizer.

Table 2 – Yields of fruit trees of Aport under different irrigation system and nutrition regimes

Treatments	Number of bloom flowers, pcs/tree	Number of fruits, pcs/tree	Percentage (%) of useful ovary into fruit	Average weight of fruit, g	Yield	
					kg/tree	kg/ha
Daily irrigation						
Control (without fertilizer)	97	7	7,2	182	1,22	82
$N_{110}P_{110}K_{120}$	152	9	5,9	195	1,82	121
$N_{55}P_{55}K_{60}$	15	3	20,0	210	0,63	42
$N_{55}P_{55}K_{60}$ + rozosol	40	6	15,0	264	1,58	100
$N_{55}P_{55}K_{60}$ + MERS	113	7	6,2	206	1,44	96
$SSD_{0,05}$		3,9			0,73	49
Periodic irrigation						
Control (without fertilizer)	27	2	7,4	177	0,35	23.5
$N_{110}P_{110}K_{120}$	17	3	17,6	218	0,72	48.7
$N_{55}P_{55}K_{60}$	19	2	7,9	200	0,4	26.7
$N_{55}P_{55}K_{60}$ + rozosol	14	3	23,6	203	0,67	45.1
$N_{55}P_{55}K_{60}$+ MERS	226	6	4,0	253	2,45	164
*$SSD_{0,05}$		2,7			1,3	87

Quality indicators of *Aport* apple fruit. Mineral nutrition is one of the factors that promotes quality and resistance to physiological diseases [13-15].

Chemical studies data for *Aport* fruit quality showed that with daily irrigation, the vitamin “C” was between 2.9-3.7 mg per percentage, while the control was 2.5 mg per percentage. With periodic irrigation, the vitamin "C" was between 2.3-5.3 mg per percentage, compared with the control without fertilizer 4.5 mg per percentage.

Table 3 – Biochemical analyses of apple fruits (variety *Aport*)

Treatment	Vitamin «C», mg/%	Sugar, %	Acidity, %	Dry matter, %
Daily irrigation				
Control (without fertilizer)	2,5	0,41	0,58	12,0
$N_{110}P_{110}K_{120}$	3,5	0,54	0,55	12,8
$N_{55}P_{55}K_{60}$	3,7	0,51	0,57	13,8
$N_{55}P_{55}K_{60}$+Розосол	2,9	0,84	0,77	15,2
$N_{55}P_{55}K_{60}$ + МЭРС	3,6	0,67	0,67	14,4
Periodic irrigation				
Control (without fertilizer)	4,5	0,40	0,42	11,8
$N_{110}P_{110}K_{120}$	2,3	0,30	0,79	13,2
$N_{55}P_{55}K_{60}$	5,3	0,96	0,71	14,2
$N_{55}P_{55}K_{60}$+Розосол	3,5	0,30	0,37	14,2
$N_{55}P_{55}K_{60}$ + МЭРС	4,0	0,50	0,49	12,0

Aport fruit sugar content was higher under daily irrigation system compared to the periodic irrigation system, irrespective of treatments.

Dry matter content range between 12.0% to 15.2% for daily irrigation, and 11.8-14.2% for periodic irrigation (table 3), thus the former is more suitable to be used as cultivars for *Aport* trees.

Conclusion. As a conclusion, treatment of mineral fertilizers of $N_{110}P_{110}K_{120}$ with daily irrigation system gave the highest yield of apple fruits at 121 kg/ha in good quality. With periodic irrigation, $N_{55}P_{55}K_{60}$ + bioproduct MERS had a significant positive effect, which the yield increased by 43 kg/ha compared to $N_{110}P_{110}K_{120}$ with daily irrigation system.

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М. К. Жумагулова[1], Ж. Б. Бакенова[1], Г. Н. Каирова[2], Т. А. Харламова[2], Рослан Исмайл[3]

[1]Қазақ ұлттық аграрлық университеті, Алматы, Қазақстан,
[2]Қазақ жеміс және жүзім шаруашылығы ғылыми-зерттеу институты, Алматы, Қазақстан,
[3]Путра университеті, Малайзия

АЛМА ЖЕМІСІНІҢ ӨНІМДІЛІГІ МЕН САПАСЫНА ТЫҢАЙТҚЫШТАР МЕН БИОПРЕПАРАТТАРДЫҢ ӘСЕРІ

Аннотация. Мақалада Іле Алатауының тау алды зонасында қара-қоңыр топырақ жағдайындағы бақта топырақ құнарлылығын сақтай отырып және сапасын төмендетпей алма жемісінің өнімділік мәліметтері келтірілген. Тыңайтқыш қолданудың аталған жүйесі топырақтағы қоректік элементтер мөлшерін, жоспарланған өнім деңгейін, топырақ-климаттық және экологиялық факторларды ескереді.

Зерттеу нәтижелері күнделікті суару кезінде ең жоғары, сапалы өнімділік 12,1 ц/га болып, $N_{110}P_{110}K_{120}$ мөлшеріндегі минералдық тыңайтқыш енгізу кезінде анықталды. Ал кезеңдік суару кезінде мұндай нәтиже $N_{55}P_{55}K_{60}$+МЭРС препаратымен тамырдан тыс өңдеу кезінде алынды – 16,4 ц/га.

Түйін сөздер: алма ағашы, минералды тыңайтқыштар, биопрепараттар, өнімділік, жеміс сапасы.

М. К. Жумагулова[1], Ж. Б. Бакенова[1], Г. Н. Каирова[2], Т. А. Харламова[2], Рослан Исмайл[3]

[1]Казахский национальный аграрный университет, Алматы, Казахстан,
[2]Казахский научно-исследовательский институт плодоводства и виноградарства, Казахстан,
[3]Университет Путра, Малайзия

ВЛИЯНИЕ УДОБРЕНИЙ И БИОПРЕПАРАТОВ НА УРОЖАЙНОСТЬ И КАЧЕСТВО ПЛОДОВ ЯБЛОНИ

Аннотация. В статье приведены данные урожая плодов яблони без ухудшения качества и сохранения почвенного плодородия в саду на темно-каштановых почвах в условиях предгорной зоне Илейского Алатау. Данная система применения удобрений учитывала содержание элементов питания почвы, планируемый уровень урожая плодов, почвенно-климатические и экологические факторы.

В результате исследований выяснено, что при ежедневном поливе наибольший урожай плодов с хорошим качеством 12,1 ц/га было при внесении минеральных удобрений $N_{110}P_{110}K_{120}$. При периодических поливах оказало внесение $N_{55}P_{55}K_{60}$ и внекорневая обработка препаратом МЭРС – 16,4 ц/га.

Ключевые слова: яблоня, минеральные удобрения, биопрепараты, урожайность, качество плодов.

Information about authors:

Bakenova Z.B. – Assoc. Prof. Dr. at Department of Soil Science and Agrochemistry, Faculty of Agrobiology, Kazakh National Agrarian University. bsb_83@mail.ru

Kairova G.N. – General Director of Kazakh Research Institute of Horticulture and Viticulture

Kharlamova T.A. – Senior researcher of Kazakh Research Institute of Horticulture and Viticulture

Roslan I. – Senior Lecturer at Department of Land Management, Faculty of Agriculture, University Putra Malaysia.

Zhumagulova M.K. – PhD student, Kazakh National Agrarian University, moldirzhumagulova1990@gmail.com