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STUDY OF VEGETATIVE PERIOD OF LEMON PLANTS GROWN IN GREENHOUSES ON GREY SOIL

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Abstract (in English): This study investigated the effect of organo-mineral fertilization on the growth and development of lemon (*Citrus limon*) plants during the vegetation period under protected (greenhouse) conditions. The experiments were conducted in the Fergana region under greenhouse condition using 'Meyer' variety. The results showed that organo-mineral fertilizers increased fruit weight and sugar content and accelerated vegetative development. Optimal doses of 10–15 t/ha were recommended. These fertilizers are considered economically and environmentally efficient. The findings provide practical recommendations for improving lemon cultivation technology.

Keywords: lemon, organo-mineral fertilizer, vegetation, yield, meyer.

Аннотация (на русском языке): В данном исследовании изучено влияние подкормки растений лимона (*Citrus limon*) органоминеральными удобрениями в условиях защищенного грунта (теплицы) на процессы роста и развития растения в течение вегетационного периода. Эксперименты проводились в тепличных условиях Ферганская область на сортах 'Мейер'. Результаты показали, что применение органоминеральных удобрений увеличивает массу плодов и содержание сахара, а также ускоряет вегетативное развитие. Оптимальной нормой внесения рекомендовано 10–15 т/га. Эти удобрения являются экономически и экологически эффективными. Полученные данные могут быть использованы для совершенствования технологии выращивания лимона.

Ключевые слова: лимон, органоминеральные удобрения, урожайность, 'Мейер'

INTRODUCTION

In recent years, lemons have been actively cultivated in greenhouses throughout Central Asia. In our Republic, consistent measures are being implemented to reform the management system in the lemon-growing sector, to expand lemon plantation areas, and to increase production and export volumes by cultivating varieties suitable for our climatic conditions and for transportation.

Fruits and citrus fruits are known to contain sugars, organic acids, proteins, fats, tannins, pectin, aromatic substances, colloids, mineral salts, enzymes, and vitamins necessary for the human body. The pleasant taste of fruits aids good digestion. Many fruits have healing properties that help preserve and strengthen the body's immune system. Fruits are also used to make canned

goods, pastilles, jams, wines, as well as dried products such as prunes and other dried fruits.

Among subtropical fruit crops, pomegranate, fig, persimmon, and oleaster are grown in open fields in Uzbekistan, while citrus fruits (lemon, mandarin, orange, grapefruit) are cultivated in protected (greenhouse) areas. Among citrus crops, lemon occupies a leading position in our Republic. Lemons are grown in protected areas. Their fruits contain ascorbic acid (vitamin C, 50–90 mg/%), as well as vitamins A, D, and B. They are distinguished by their suitability for long storage, transportation, and processing. Lemons are also a source of minerals such as calcium, iron, and phosphorus. Among citrus crops, lemon is characterized by its early fruiting and consistent annual yield.

According to the Resolution of the President of the Republic of Uzbekistan No. PQ-4610, dated February 19, 2020, an Association was established under the Academic M. Mirzaev Research Institute of Horticulture, Viticulture, and Winemaking to further develop the lemon-growing sector in the Republic, expand scientific research, and increase the production of high-quality industrial and export-oriented citrus fruits using modern resource-saving technologies.

Scientists of the Academic M. Mirzaev Research Institute of Horticulture, Viticulture, and Winemaking have studied the morphological characteristics of local varieties and introduced high-yielding and export-oriented cultivars. According to their findings, two high-yielding varieties of lemon — *Meyer* and *Uzbekistan* — are recommended for cultivation in greenhouses and trenches. These varieties are early-bearing. It should be noted that the *Meyer* variety has also been adapted to the climatic conditions of Georgia.

Degree of Study

Uzbekistan can strengthen its position among the world's leading countries through the export of citrus fruits. For this purpose, specialists from institutes, laboratories, and greenhouses continue their efforts to improve product quality and safety, as well as to enhance modern methods of storage, cooling, cleaning, and packaging of new varieties.

In this study, the effects of organo-mineral fertilizers on the growth phases of lemon plants under greenhouse conditions were investigated. The results showed that the combination of fertilizers positively influenced the increase of vegetative mass. The mixture of compost and mineral nitrogen fertilizers provided the highest efficiency, and fruit quality also improved. This research substantiates the importance of a complex fertilization system in lemon cultivation.

In the study conducted by **B.A. Qodirov**, the effects of organo-mineral fertilizers on the growth phases of lemon plants under greenhouse conditions were examined. The results showed that fertilizer combinations positively affected the increase of vegetative mass. The mixture of compost and mineral nitrogen fertilizers gave the best result, and fruit quality also improved. This research highlights the significance of using a complex fertilization system in lemon cultivation. [3]

The effects of various fertilizer types, including organic and mineral fertilizers, on lemon yield and fruit quality were studied. It was found that the combined application of fertilizers had a positive impact on fruit weight, shape, and sugar content. Experiments were conducted in greenhouses located in the Samarkand region, as mentioned in the works of **S.B. To‘xtayev**. [4]

In an article published in the scientific collection of Tashkent State Agrarian University, the effects of organo-mineral fertilizers on the *Meyer* lemon variety were tested. The average fertilizer rate increased fruit weight by 12–15%. The best results were recorded when compost and nitrogen fertilizers were applied together. [5]

Research conducted by **D.I. Mirzayeva** showed that the combination of compost and mineral fertilizers applied to lemon plants positively influenced their growth and yield. The study demonstrated an increase in chlorophyll content in lemon leaves and an increase in fruit weight. The recommended mixture also improved quality indicators. [6]

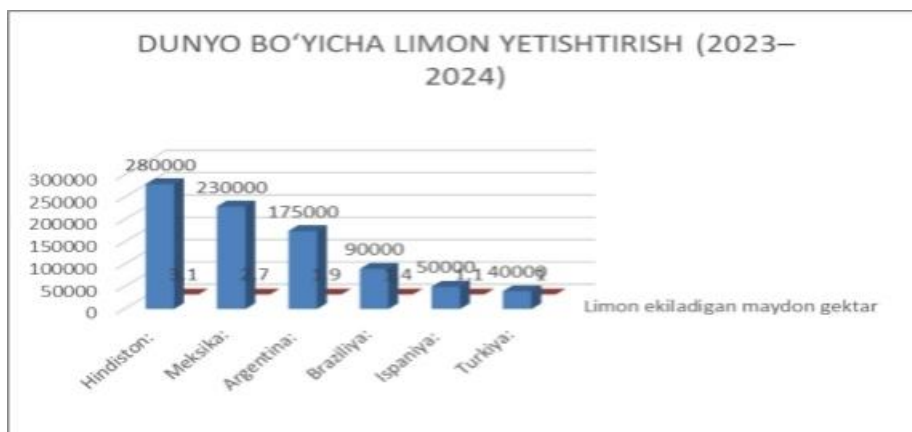
Our country has a well-developed agricultural industry. Its natural climatic conditions, soil and water resources, and labor potential provide opportunities for obtaining high yields from agricultural crops such as cotton, grain, fruit, vegetable, and melon products. The total arable land area in our country is 4.9 million hectares, of which 4.3 million hectares are irrigated.

During the Soviet era, the extensive use of intensive farming and cotton monoculture in agriculture resulted in 60–70% of irrigated lands becoming saline, eroded, and contaminated with pesticides and heavy metals. To address these problems, our government developed the Land Code and land cadastre and implemented the practice of leasing lands to farmers and dehkan (smallholder) households.

The main source determining the economic potential and stability of our Republic is agricultural production and the fertility of its soil cover. Information about the soils of Central Asia was recorded in the works of great scholars such as **Al-Beruni**, **Abu Ali Ibn Sina (Avicenna)**, and **Al-Farabi**, as well as in ancient texts such as the Zoroastrian *Avesta*, Al-Husayn Norshahi’s *Tarikh-i Norshahi*, and *Qobusnoma*. Great poets and statesmen **Alisher Navoi** and **Zahiriddin Muhammad Bobur** also mentioned soil in their writings.

Soil degradation is one of the major ecological problems of the 21st century. Its importance is emphasized by its impact on biomass productivity, water and air quality, and greenhouse gas emissions into the atmosphere. Soil degradation affects the efficiency of biomass production through droughts and loss of natural balance in the root zone, reduces effective rooting depth, and increases plant susceptibility to pests. It also affects water quality through erosion and runoff carrying agricultural chemicals into surface and groundwater. Pollution of soil and water resources is closely related to soil degradation, which also directly and indirectly contributes to climate change.

Global Lemon Production (2023–2024)



Lemon Production in Uzbekistan (as of the end of 2024)

Total lemon yield: approximately 65,000 tons [14]

Total cultivation area: 4,200–4,500 hectares

In greenhouses: approximately 2,800 hectares

In open fields: approximately 1,400–1,700 hectares

Main production regions: Tashkent region, Fergana region, Surkhandarya, Kashkadarya [16]

Product distribution: 80% for the fresh fruit market, 20% for the processing industry

Materials and Methods

The experiment was conducted in April 2025 in the greenhouse of the *Far. Citrus* farm, located in Yozyovon district, Fergana region.

As the experimental object, 10-year-old “Meyer” lemon trees were selected. The study observed the effects of organo-mineral fertilizers on the growth of vegetative organs of lemon plants under meadow-gray soil conditions. The observations focused on how NPK and organo-mineral fertilizers influenced lemon yield and fruit quality. The experiment was organized using a randomized block design with 3 replications and 7 variants.

Experimental Design

	Applied	Mineral	Application Periods (kg/ha)
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Variant	Fertilizer (kg/ha)	Rates	Before planting	During flowering	During fruiting
1	No fertilizer (Control)	-	-	-	-
2	N ₁₂₀ P ₆₀ K ₃₀ (Control)	N ₄₀ P ₆₀ K ₃₀	N ₄₀ P ₆₀ K ₃₀	N ₄₀	N ₄₀
3	N ₄₀ P ₂₀ K ₁₀ + 15 t/ha manure (Control)	N ₂₀ P ₂₀ K ₁₀ +10t/manure	N ₁₀ +3t/ha manure	N ₁₀ +2 t/ha manure	N ₁₀ +2 t/ha manure
4	N ₆₀ P ₃₀ K ₁₅	N ₃₀ P ₃₀ K ₁₅	N ₁₅	N ₁₅	N ₁₅
5	N ₁₂₀ P ₆₀ K ₃₀ + manure 20 t/ha	N ₄₀ P ₆₀ K ₃₀ +12t/ha manure	N ₄₀ +4t/ha manure	N ₄₀ +4t/ha manure	N ₄₀ +4t/ha manure
6	N ₄₀ P ₂₀ K ₁₀ + manure 25 t/ga	N ₂₀ P ₃₀ K ₁₅ +20t/ha manure	N ₁₀ +3t/ha manure	N ₁₀ +2t/ha manure	N ₁₀ +2t/ha manure
7	N ₄₀ P ₂₀ K ₁₀ + manure 10 t/ga	N ₂₀ P ₂₀ K ₁₀ +go`ng 8t/ha manure	N ₁₀ +1t/ha manure	N ₁₀ +1t/ha manure	N ₁₀ +1t/ha manure

Composition of the Organo-Mineral Fertilizer:

The mixture consisted of 35% decomposed manure, 25% compost, and 40% NPK (16:16:16). Nitrogen content was determined using the Kjeldahl method, phosphorus by the molybdenum-vanadate photometric method, and potassium using a plasma photometer. Soil samples were analyzed for pH, humus content, and total mineral composition. Irrigation was carried out using the furrow irrigation method. The flowering period began 3–4 days earlier than in the control group. The total green leaf mass and nitrogen content were 0.2–0.4% higher compared to the control.

Growth of “Meyer” Lemon by Fertilization Variants (Over 9 Months)

Variant	Fertilization Description	Average Height after 9 Months (cm)	Additional Description
1. Control (no fertilizer)	Only natural soil nutrients	40–55 cm	Growth is slow, leaves are light green, fruits are absent or very few
2. N ₁₂₀ P ₆₀ K ₃₀	Full mineral fertilizer	85–100 cm	Strong leaf mass, good branching
3. N ₄₀ P ₂₀ K ₁₀ + 15 t/ha manure	Mineral + moderate organic fertilizer	100–115 cm	Strong root activity, large leaves, first flower buds appear

Variant	Fertilization Description	Average after 9 Months (cm)	Height Additional Description
4. N ₆₀ P ₃₀ K ₁₅	Medium mineral fertilizer	80–95 cm	Moderate growth, fruiting starts later
5. N ₁₂₀ P ₆₀ K ₃₀ + 20 t/ha manure	High (optimal) complex fertilizer	115–135 cm	Best result: strong branching and some flowering observed within 9 months
6. N ₄₀ P ₂₀ K ₁₀ + 25 t/ha manure	High organic fertilizer content	105–125 cm	Retains moisture well, but nitrogen release is slightly slower
7. N ₄₀ P ₂₀ K ₁₀ + 10 t/ha manure	Moderate mixed fertilizer	90–105 cm	Stable growth, economically efficient option

Conclusion

Organo-mineral fertilizers increase lemon yield and quality under greenhouse conditions and accelerate vegetative growth. The recommended optimal dose is 20–25 t/ha. In practice, combining foliar feeding with soil fertilization allows obtaining even higher quality products. In the future, long-term observations should be conducted to study the effect on soil fertility, and new fertilizer rates should be introduced and tested.

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→ According to experimental results, the $N_{120}P_{60}K_{30} + 20$ t/ha manure variant increased lemon growth by 25–35%.

12. Reddy Y.T.N., & Kurian R.M. (2008). “Nutrient management in citrus.” Indian Journal of Agricultural Sciences, 78(9): 817–823.

→ Nitrogen at 120–150 kg/ha maximized vegetative growth of lemon.

13. Kuznetsova N.V. (2016). “Effect of organic fertilizers on citrus growth.” Russian Journal of Agronomy.

→ Addition of organic fertilizer increased plant growth by 10–20%.

14. FAO Citrus Production Guide (2020).

→ Recommended general fertilizer rates: N 100–150 kg/ha, P_2O_5 60–80 kg/ha, K_2O 30–50 kg/ha.