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Effect of mineral fertilizer forms and rates on the germination rate and plant density of “Fayz-baraka” Jerusalem artichoke variety

Topinambur o'simligi Fayz-baraka navining unib chiqish darajasi va ko'chat qalinligiga mineral o'g'itlar shakllari va me'yorlarining ta'siri

Влияние форм и норм минеральных удобрений на всхожесть и густоту стояния растений топинамбура сорта «Файз-барака»

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Abstract. The article examines the effect of nitrogen fertilizer forms (ammonium sulfate, urea and ammonium nitrate) and rates (N_{60} – N_{150} against a $P_{90}K_{90}$ background) on seedling emergence and plant density of the Jerusalem artichoke variety Fayz-baraka. In the 2025 field experiment plant density increased in all variants over the observation dates, with the most intensive increase between 12 and 17 April (on average by 22–24 thousand plants/ha). Ammonium nitrate was the most effective form: at $N_{120}P_{90}K_{90}$ plant density reached 94.1 thousand plants/ha after thinning and 92.9 thousand plants/ha at the end of the growing season. $N_{120}P_{90}K_{90}$ was the optimal rate for all fertilizer forms, and increasing it to N_{150} reduced the indicators.

Keywords: Jerusalem artichoke; Fayz-baraka variety; nitrogen fertilizers; ammonium nitrate; urea; ammonium sulfate; emergence; plant density

O'ZBEKCHA

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Annotatsiya. Maqolada Fayz-baraka navli topinambur nihollarining unib chiqish darajasi va ko'chat qalinligiga azotli o'g'itlar shakllari (ammoniy sulfat, karbamid, ammoniy nitrat) va me'yorlarining ($P_{90}K_{90}$ fonida N_{60} – N_{150}) ta'siri o'rganilgan. 2025-yilgi dala tajribasida barcha variantlarda ko'chat qalinligi kuzatuv muddatlari bo'yicha ortib borgan, eng jadal o'sish 12.04–17.04 oralig'ida (o'rtacha 22–24 ming tup/ga) qayd etilgan. Ammoniy nitrat eng yuqori samaradorlik ko'rsatgan: $N_{120}P_{90}K_{90}$ me'yorida ko'chat qalinligi yaganadan keyin 94,1 ming tup/ga, amal davri oxirida 92,9 ming tup/ga ni tashkil etgan. Barcha o'g'it shakllari uchun $N_{120}P_{90}K_{90}$ optimal me'yor bo'lib, uni N_{150} gacha oshirish ko'rsatkichlarning pasayishiga olib kelgan.

Kalit so'zlar: topinambur; Fayz-baraka navi; azotli o'g'itlar; ammoniy nitrat; karbamid; ammoniy sulfat; unib chiqish; ko'chat qalinligi

РУССКИЙ

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Аннотация. В статье изучено влияние форм азотных удобрений (сульфат аммония, карбамид, аммиачная селитра) и их норм (N_{60} – N_{150} на фоне $P_{90}K_{90}$) на всхожесть и густоту стояния

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растений топинамбура сорта «Файз-барака». В полевом опыте 2025 года густота стояния во всех вариантах возрастала по срокам наблюдений; наиболее интенсивный прирост отмечен между 12.04 и 17.04 (в среднем на 22–24 тыс. растений/га). Наибольшую эффективность показала аммиачная селитра: при норме $N_{120}P_{90}K_{90}$ густота стояния после прореживания составила 94,1 тыс. растений/га, в конце вегетации — 92,9 тыс. растений/га. Для всех форм удобрений оптимальной оказалась норма $N_{120}P_{90}K_{90}$; её повышение до N_{150} снижало показатели.

Ключевые слова: топинамбур; сорт «Файз-барака»; азотные удобрения; аммиачная селитра; карбамид; сульфат аммония; всхожесть; густота стояния

1. KIRISH

Introduction

Zamonaviy qishloq xo'jaligida oziq-ovqat xavfsizligini ta'minlash, tuproq unumdorligini oshirish va ekologik muvozanatni saqlash muhim masalalardan biri hisoblanadi. Shu nuqtai nazardan, agrosanoat kompleksida yuqori hosilli, sermahsul va ekologik toza mahsulot beruvchi ekinlarni yetishtirish dolzarb masalaga aylangan. Bunday ekinlardan biri bu — Topinambur (Jerusalem artishoki, *Helianthus tuberosus* L.) hisoblanadi.

Topinambur yuqori biologik faollikka ega bo'lib, tarkibida inulin, vitaminlar (C, B1, B2, B6), temir, kaliy, kalsiy, magniy va boshqa foydali moddalarga boy. Shuningdek, u qandli diabet, yurak-tomir, oshqozon-ichak kasalliklarida foydali bo'lgan o'simlik hisoblanadi. Uning ildiz mevalari yem-xashak, oziq-ovqat va dori-darmon sanoatida keng qo'llaniladi.

Topinambur o'sishini jadallashtirish va hosildorligini oshirishda agrotekhnika tadbirlar, xususan, mineral o'g'itlar, ayniqsa azotli o'g'itlar me'yori to'g'ri belgilash muhim rol o'ynaydi. Ushbu maqolada topinambur o'simligining o'sishi, rivojlanishi va hosildorligiga o'g'itlarning miqdoriy ta'siri tahlili keltirilgan.

Topinambur ekini tuganaklarini unib chiqishi uchun havo harorati 12 °C dan, maysalarni boshlang'ich o'sib rivojlanishi uchun eng kamida 14-15 °C, keyingi fazalardagi maqbul havo harorati 26-28 °C kam bo'lmasligi talab etiladi. O'suv davrining 25-30 kunlari asosiy poyaning 5-8 barg qo'ltiqlaridan dastlabki bachki poyachalar shakllanish kuzatilsada, ular o'suv davri davomida sekin rivojlanadi. Ushbu bachki novdalardan asosiy poya zararlangandagina birlamchi shoxlar juda tez rivojlanadi. O'simlikning bu xususiyatidan chorvachilik yo'nalishida keng foydalanilsa bo'ladi. O'suv davrining 60-65 kunlari ildiz asosida birinchi hosil tuganaklari shakllana boshladi. Kartoshkadan farqliroq bu jarayon 80-100 kun davom etishi kuzatildi. Asosiy poya zararlanganda esa yon shoxlari rivojlanguncha (15-20 kun) tuganaklarning o'sishi butunlay to'xtadi [1]. Bitta o'simlikdagi poyalar soni o'zgaruvchan belgi bo'lib, tuganaklarning yirikligiga bog'liq holda, odatda "Mo'jiza" navida bitta tuganakdan 3-8

donagacha poyalar shakllanadi. Bu ko'p hollarda tuganakning yirikligiga va undagi ko'zlar soniga bog'liq bo'ladi. Topinamburning "Mo'jiza" navlarini o'suv davri bosqichlari (faza) davomiylikiga ekish muddatlarining ta'siri, asosan o'suv davrining unib chiqish davridan shonalash davrigacha bo'lgan vaqtda ko'rish mumkin bo'lib, tuganaklar qancha erta ekilsa, o'simlik unib chiqqandan keyingi davrdan shonalashgacha bo'lgan vaqt nisbatan uzoqroq davom etadi. O'simlik gullash bosqichiga o'tganda esa, o'sish sezilarli sekinlashishi, o'simlik to'la gullash bosqichiga kirganda esa, o'sish butunlay to'xtashi kuzatiladi. Topinambur ekinining fevral-mart oylarida ekilishi hosildorlikning sezilarli darajada ko'payishi hamda o'simlikdagi yirik tuganaklar miqdorining ortishiga sabab bo'lishi bilan bir vaqtda o'simlik parvarishi uchun sarflanadigan sarf-xarajatlarni ham kamayishiga ijobiy ta'sir qiladi [2-5].

2. NATIJALAR VA MUHOKAMA

Results and discussion

Ammoniy nitrat qo'llanilgan variantlar barcha o'g'it shakllari ichida eng yuqori ko'rsatkichlarni namoyon etganligini ta'kidlab o'tishni joiz deb hisobladik. $N_{120}P_{90}K_{90}$ da ko'chat qalinligi 33,9-99,3 ming tup/ga, yaganadan keyin 94,1 ming tup/ga, amal davri oxirida 92,9 ming tup/ga ni tashkil etdi. Bu ko'rsatkichlar ammoniy sulfatga nisbatan 1,7-2,9 ming tup/ga, karbamidga nisbatan esa 0,6-1,5 ming tup/ga ga yuqori bo'ldi. 2025-yilda barcha variantlar bo'yicha yuqori ko'rsatkichlarning qayd etilishi, asosan, qulay harorat rejimi va optimal namlik ta'minlanganligi bilan izohlash mumkin.

2025-yilda kuzatuv muddatlari bo'yicha olib borilgan tahlillar shuni ko'rsatdiki, barcha variantlarda ko'chat qalinligi vaqt o'tishi bilan oshib bordi. Eng intensiv o'sish ikkinchi (12.04) va uchinchi (17.04) kuzatuvlar oralig'ida kuzatilgan bo'lib, bu davrda ko'chat qalinligi o'rtacha 22-24 ming tup/ga ga oshdi. Qulay iqlim sharoitlari tufayli yagana qilinganidan keyin va amal davri oxirida ko'rsatkichlarning pasayishi boshqa yillarga nisbatan kamroq darajada kuzatildi.

1-jadval

Topinambur o'simligi nihollarining unib chiqish darajasi va ko'chat qalinligiga mineral o'g'itlar shakllari va me'yorlarining ta'siri (2025-yil) / **Table 1.** Effect of mineral fertilizer forms and rates on seedling emergence and plant density of Jerusalem artichoke (2025)

№	Qo'llanilgan azotli o'g'it turlari	Mineral o'g'it me'yorlari	Kuzatuv muddatlari				Ko'chat qalinligi, ming.tup/ga	
			07.04	12.04	17.04	20.04	Yaganadan keyin	Amal davri oxirida
1	(NH ₄) ₂ SO ₄ (Ammoniy sulfat)	O'g'itsiz (nazorat)	28,4	51,2	72,6	90,4	88,4	86,9
2		P ₉₀ K ₉₀	29,1	53,5	74,4	91,5	89,6	87,8
3		N ₆₀ P ₉₀ K ₉₀	30,3	54,8	76,5	91,9	90,6	88,2
4		N ₉₀ P ₉₀ K ₉₀	31,5	55,6	77,4	92,2	90,9	89,7
5		N ₁₂₀ P ₉₀ K ₉₀	32,4	57,5	79,2	94,8	92,8	90,6
6		N ₁₅₀ P ₉₀ K ₉₀	31,6	56,7	78,6	93,0	91,9	90,3
7	CO(NH ₂) ₂ (Karbamid)	N ₆₀ P ₉₀ K ₉₀	31,3	55,4	76,9	92,7	90,8	89,4
8		N ₉₀ P ₉₀ K ₉₀	32,4	56,6	78,4	93,3	91,6	90,5
9		N ₁₂₀ P ₉₀ K ₉₀	33,5	58,6	80,2	95,2	93,3	91,9
10		N ₁₅₀ P ₉₀ K ₉₀	33,0	58,0	80,1	93,4	92,6	91,2
11	NH ₄ NO ₃ (Ammoniy nitrat)	N ₆₀ P ₉₀ K ₉₀	31,5	55,9	77,7	93,1	91,6	90,0
12		N ₉₀ P ₉₀ K ₉₀	32,8	57,6	79,4	93,3	92,7	91,4
13		N ₁₂₀ P ₉₀ K ₉₀	33,9	59,3	81,6	95,1	94,1	92,9
14		N ₁₅₀ P ₉₀ K ₉₀	33,5	58,9	80,0	93,9	93,7	92,5

3. XULOSA

Conclusion

Yuqorida o'tkazilgan dala tajribalari natijalari topinambur o'simligi nihollarining unib chiqish darajasi va ko'chat qalinligiga mineral o'g'itlar shakllari va me'yorlarining sezilarli ta'sir ko'rsatishi aniqlandi. Tadqiqotda ammoniy sulfat, karbamid va ammoniy nitrat kabi uch xil azotli o'g'it shakllari hamda ularning N₆₀, N₉₀, N₁₂₀, N₁₅₀ me'yorlari P₉₀K₉₀ fonida qo'llanilib, olingan natijalar o'rtacha uch yillik ko'rsatkichlar asosida baholandi. O'rganilgan azotli o'g'it shakllari orasida ammoniy nitrat eng yuqori samaradorlikka ega bo'lib, uning N₁₂₀P₉₀K₉₀ me'yori ko'chat qalinligining maksimal darajaga (o'rtacha 93,1 ming tup/ga) chiqishini ta'minlaydi. Karbamid o'rtacha samaradorlikni (92,2 ming tup/ga), ammoniy sulfat esa nisbatan past samaradorlikni (91,4 ming tup/ga) namoyon qildi. Barcha uchala o'g'it shakli uchun N₁₂₀P₉₀K₉₀ optimal me'yor ekanligi aniqlandi, bu me'yordan oshib ketish (N₁₅₀) ko'rsatkichlarning o'rtacha 0,4-0,5 ming tup/ga.ga pasayishiga olib keldi.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The study was carried out in field conditions with plants only; no human participants or animals were involved, and no ethics committee approval was required.

Informed consent

The author has read and approved the final version of the manuscript and has given her consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the table of this article; the primary records are available from the author on reasonable request.

Conflict of interest

The author declares no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Ensuring food security, increasing soil fertility and maintaining ecological balance are among the key tasks of modern agriculture, and the cultivation of high-yielding crops that give ecologically clean products is therefore of growing importance. Jerusalem artichoke (*Helianthus tuberosus* L.) is one such crop: it has high biological activity and contains inulin, vitamins (C, B1, B2, B6), iron, potassium, calcium, magnesium and other useful substances, is regarded as beneficial in diabetes and cardiovascular and gastrointestinal diseases, and its tubers are widely used for fodder, food and pharmaceutical purposes. Agrotechnical measures, in particular the correct choice of mineral fertilizers and especially of nitrogen fertilizer rates, play an important role in accelerating its growth and increasing its yield. The aim of the article was to analyse the effect of the forms and rates of mineral fertilizers on the emergence and plant density of the Jerusalem artichoke variety Fayz-baraka.

Materials and methods

Literature data show that tubers of Jerusalem artichoke require an air temperature of at least 12 °C for sprouting, at least 14–15 °C for the initial growth of seedlings and 26–28 °C in the later phases; lateral shoots form in the axils of the 5th–8th leaves of the main stem on the 25th–30th day of growth and develop rapidly when the main stem is damaged, and tuber formation begins on the 60th–65th day and lasts 80–100 days. In the field experiment of 2025, three forms of nitrogen fertilizer — ammonium sulfate ((NH₄)₂SO₄), urea (CO(NH₂)₂) and ammonium nitrate (NH₄NO₃) — were applied at rates of N₆₀, N₉₀, N₁₂₀ and N₁₅₀ against a P₉₀K₉₀ background and compared with an unfertilized control and a P₉₀K₉₀ variant (14 variants in total). Seedling emergence was recorded on 7, 12, 17 and 20 April, and plant density (thousand plants per hectare) was determined after thinning and at the end of the growing season. The location of the experiment, soil characteristics, plot size and number of replications are not described in the article.

Results and discussion

In all variants plant density increased over the observation dates, and the most intensive increase occurred between the second (12 April) and third (17 April) observations, when density rose on average by 22–24 thousand plants per hectare. In the unfertilized control the values were 28.4, 51.2, 72.6 and 90.4 on the four observation dates, 88.4 thousand plants/ha after thinning and 86.9 thousand plants/ha at the end of the growing season. Ammonium nitrate gave the highest values of all fertilizer forms: at $N_{120}P_{90}K_{90}$ the values on the observation dates were 33.9, 59.3, 81.6 and 95.1, plant density after thinning was 94.1 thousand plants/ha and at the end of the growing season 92.9 thousand plants/ha, which was 1.7–2.9 thousand plants/ha higher than with ammonium sulfate and 0.6–1.5 thousand plants/ha higher than with urea. With urea the best rate, $N_{120}P_{90}K_{90}$, gave 93.3 and 91.9 thousand plants/ha, and with ammonium sulfate 92.8 and 90.6 thousand plants/ha after thinning and at the end of the season. The high values recorded in all variants in 2025 are explained mainly by a favourable temperature regime and optimal moisture supply, which also reduced the decline in density after thinning and at the end of the growing season compared with other years.

Conclusion and contribution

The forms and rates of mineral fertilizers had a significant effect on the emergence and plant density of Jerusalem artichoke seedlings. Of the nitrogen forms studied, ammonium nitrate was the most effective, and its $N_{120}P_{90}K_{90}$ rate ensured the maximum plant density; urea showed medium and ammonium sulfate relatively lower efficiency. $N_{120}P_{90}K_{90}$ was the optimal rate for all three fertilizer forms, while increasing the nitrogen rate to N_{150} reduced the indicators by 0.4–0.5 thousand plants per hectare on average. According to the author, these conclusions are based on average three-year indicators.

ADABIYOTLAR RO'YXATI

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