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MATERIALS

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« INTEGRATION OF SCIENCE, EDUCATION AND INDUSTRY: GLOBAL CHALLENGES, INNOVATIVE SOLUTIONS AND SUSTAINABLE DEVELOPMENT»

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EFFECTS OF SUBSTRATE, IRRIGATION REGIME, AND MINERAL NUTRITION ON THE GROWTH AND PRODUCTIVITY OF PIMPINELLA ANISUM L. UNDER GREENHOUSE CONDITIONS

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Annotatsiya. *Pimpinella anisum L. (anis) qimmatli dorivor va efir moyli ekin bo'lib, uning hosildorligi ko'p jihatdan yetishtirish sharoitlariga bog'liq. Tadqiqotda substrat turi (tuproq va kokos tolasi), sug'orish hajmi (50–200 ml) hamda mineral oziqlantirish (bor bilan boyitilgan kaltsiy nitrat, 17N+32CaO+1B) ning issiqxona sharoitida anisning o'sish ko'rsatkichlari va hosildorligiga ta'siri to'liq faktorli tajriba asosida o'rganildi. O'simlik umumiy uzunligi, ildiz uzunligi, barglar soni, ho'l va quruq biomassa hamda soyabon soni o'lchandi; ma'lumotlar bir faktorli ANOVA va Tukey HSD testi yordamida tahlil qilindi. Ikkala substrat uchun ham 150 ml sug'orish hajmi optimal bo'lib, vegetativ o'sish va quruq modda to'planishi o'rtasida eng yaxshi muvozanatni ta'minladi. Tuproq substrati ko'proq biomassa to'planishiga, kokos tolasi esa yaxshiroq rivojlangan ildiz tizimiga xizmat qildi. Bor bilan boyitilgan kaltsiy nitrat bilan oziqlantirish o'simlik bo'yi, barglar soni, ildiz massasi va soyabonlar sonini sezilarli darajada oshirdi ($p < 0,05$). Natijalar O'zbekistonda anisni issiqxona sharoitida resurstejamkor yetishtirish texnologiyalarini ishlab chiqish uchun asos bo'lib xizmat qiladi.*

Kalit so'zlar: *anis, Pimpinella anisum, issiqxona yetishtirish, substrat turi, sug'orish rejimi, mineral oziqlantirish, biomassa, hosildorlik.*

Аннотация. *Pimpinella anisum L. (анис) — ценная лекарственная и эфирномасличная культура, продуктивность которой во многом зависит от условий выращивания. В исследовании изучено влияние типа субстрата (почва и кокосовый койр), объёма полива (50–200 мл) и минерального питания (нитрат кальция с бором, 17N+32CaO+1B) на морфометрические показатели роста и продуктивность аниса в условиях защищённого грунта при полном факторном эксперименте. Измерялись общая длина растения, длина корня, число листьев, сырая и сухая биомасса, число зонтиков; данные обработаны однофакторным дисперсионным анализом (ANOVA) с тестом Тьюки (HSD). Оптимальным для обоих субстратов оказался объём полива 150 мл, обеспечивший наилучший баланс вегетативного роста и накопления сухого вещества. Почвенный субстрат способствовал большему накоплению биомассы, тогда как кокосовый койр — более развитой корневой системе. Минеральное питание нитратом кальция с бором достоверно улучшило высоту растений, число листьев, массу корней и число зонтиков ($p < 0,05$). Результаты могут служить основой для ресурсосберегающих технологий тепличного выращивания аниса в Узбекистане.*

Ключевые слова: *анис, Pimpinella anisum, тепличное выращивание, тип субстрата, режим полива, минеральное питание, биомасса, продуктивность*.

Abstract. *Pimpinella anisum L. (anise) is a valuable medicinal and essential-oil crop whose productivity strongly depends on cultivation conditions. This study evaluated the effects of substrate type (soil vs. coconut coir), irrigation volume (50–200 ml), and mineral nutrition (calcium nitrate with boron, 17N+32CaO+1B) on the morphometric growth and productivity of anise under controlled greenhouse conditions using a full factorial design. Total plant length, root length, leaf number,*

fresh and dry biomass, and umbel number were measured, and data were analyzed by one-way ANOVA with Tukey's HSD test. An irrigation volume of 150 ml was optimal for both substrates, providing the best balance between vegetative growth and dry matter accumulation. Soil substrate favored greater biomass accumulation, while coconut coir supported more developed root systems. Mineral nutrition with calcium nitrate and boron significantly improved plant height, leaf number, root mass, and umbel formation ($p < 0.05$). These findings provide a basis for resource-efficient greenhouse cultivation technologies for anise in Uzbekistan.

Keywords: *anise, Pimpinella anisum, greenhouse cultivation, substrate type, irrigation regime, mineral nutrition, biomass, productivity.*

Background

Pimpinella anisum L. (anise) is a valuable medicinal and essential-oil crop whose yield and quality directly depend on cultivation conditions, including substrate type, irrigation regime, and mineral nutrition level.

Aim of the Study

To comparatively evaluate the effects of substrate type (soil, coconut coir), irrigation volume (50, 100, 150, and 200 ml), and mineral nutrition (calcium nitrate supplemented with boron, 17N+32CaO+1B) on the morphometric growth parameters, biomass, and productivity of Pimpinella anisum L. under greenhouse conditions.

Materials and Methods

The study was conducted in a controlled greenhouse at the Institute of Fundamental and Applied Research, TIIAME National Research University (Tashkent), at 22–25 °C daytime and above 18 °C nighttime temperature, 60–70% relative humidity, and a 16-hour photoperiod. A full factorial randomized design (CRD/RCBD) was applied: 2 substrates (soil, coconut coir) × 2 mineral nutrition

variants (control and 17N+32CaO+1B) × 4 irrigation volumes (50, 100, 150, 200 ml), with several biological replicates per treatment. Total plant length, stem and root length, leaf number, fresh and dry biomass, and umbel number were recorded. Data were analyzed by one-way ANOVA followed by Tukey's HSD test at $p \leq 0.05$.

Results and Discussion

Effect of irrigation regime. For soil substrate, the best indicators were obtained at 150 ml irrigation: total plant length 75.0 cm, root length 10.3 cm, fresh biomass 66.7 g, and the highest dry biomass among all treatments (19.1 g). At 200 ml, fresh biomass reached its maximum (80.1 g), but dry biomass decreased to 12.9 g, indicating an unfavorable effect of excess moisture on dry matter accumulation. For coconut coir substrate, 150 ml was likewise optimal: total plant length 74.3 cm, root length 18.0 cm (the maximum across all treatments), and fresh biomass 57.8 g.

Treatment	Plant length, cm	Root length, cm	Fresh biomass, g	Dry biomass, g
Soil, 50 ml	67.1	6.4	44.9	18.2
Soil, 100 ml	59.3	5.3	46.4	13.7
Soil, 150 ml	75.0	10.3	66.7	19.1
Soil, 200 ml	—	8.3	80.1	12.9
Coconut, 50 ml	57.7	13.0	31.4	4.8
Coconut, 100 ml	62.3	—	28.9	14.1
Coconut, 150 ml	74.3	18.0	57.8	13.4

Table 1. Growth and biomass parameters of Pimpinella anisum L. depending on irrigation regime and substrate.

Effect of substrate. Comparison of substrates showed that soil supported greater fresh and dry biomass accumulation, especially at 150 and 200 ml irrigation, whereas

coconut coir promoted more intensive root system development (greater root length and branching), associated with better substrate aeration and porosity.

Effect of mineral nutrition. Application of calcium nitrate with boron significantly improved all major parameters in both substrates: plant height increased to 67.0 cm (coconut coir) and 65.0 cm (soil) vs. 65.0 and 60.0 cm in the control; leaf number increased from 13 to 19 (coconut coir) and from 12 to 18 (soil); root mass from 0.4 to 0.8 g (coconut coir) and from 1.0 to 1.4 g (soil); umbel number from 8 to 15 (coconut coir) and from 7 to 14 (soil).

Statistical analysis. One-way ANOVA confirmed statistically significant differences among treatments ($p < 0.05$). Tukey's HSD revealed the most pronounced differences between the “Soil, 150 ml” and “Coconut, 150 ml” groups, particularly for root development ($p = 0.009$) and fresh biomass accumulation ($p = 0.015$), as well as a significant effect of mineral nutrition on all evaluated parameters ($p = 0.011–0.026$).

Conclusion

Substrate, irrigation volume, and mineral nutrition were found to have significant and interrelated effects on the growth and productivity of Pimpinella anisum L. An irrigation volume of 150 ml was optimal for both substrates; mineral nutrition based on calcium nitrate with boron significantly improved vegetative growth and reproductive organ formation. Soil substrate provided greater biomass accumulation, while coconut coir supported a more developed root system. These findings should be considered in the development of resource-efficient greenhouse cultivation technologies for anise in Uzbekistan.

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