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RESULTS OF STUDIES CONDUCTED IN 2024–2025 ON ENHANCING THE RAW MATERIAL YIELD OF MILK THISTLE (SILYBUM MARIANUM L.) IN SAMARKAND PROVINCE

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Abstract

Field experiments were conducted in 2024–2025 to enhance the raw material (seed) yield of milk thistle (Silybum marianum L.) under Samarkand Province conditions. The study examined the effect of three different sowing dates on plant growth and seed yield. Results showed that the earliest sowing (mid-March) produced the highest raw material yield. Delayed sowing shortened plant development, significantly reducing seed yield. Analysis of two years of data supports early spring sowing as the optimal agro-technical practice for milk thistle cultivation in Samarkand, providing a foundation for improving its cultivation technology.

Keywords: Milk thistle, Silybum marianum, raw material yield, sowing date, medicinal plant, Samarkand climate, agro-technics.

Introduction

Milk thistle (Silybum marianum L.), commonly known as "white thistle," is a valuable medicinal plant historically used for treating and preventing liver diseases. Its active compound, silymarin, a flavonoid, is a potent hepatoprotector known for regenerating liver tissues. Today, dry extracts from milk thistle seeds are widely used as hepatoprotective and antioxidant supplements, not only for liver conditions but also for diabetes and other ailments. Consequently, global demand for milk thistle seed-based products is increasing.

With the growing need for medicinal plant raw materials, cultivating these plants has become a critical issue. Many medicinal plants, including milk thistle, face challenges such as low yield, uneven seed ripening, and seed shedding, complicating harvest and reducing raw material output. For instance, international studies indicate that milk thistle seed yields range from 0.25 to 1.80 tons per hectare, depending on climate and agro-technical practices. Thus, identifying effective cultivation methods and optimal conditions is essential for improving yield. In Uzbekistan, efforts are underway to meet the demand for milk thistle raw materials through local cultivation. A state program for 2022–2026 identifies milk thistle as a promising medicinal crop for large-scale cultivation and industrial processing. Samarkand Province's soil and climate are suitable for this crop; however, determining optimal sowing dates and agro-technical measures is necessary, considering the plant's biological characteristics. This study aims to investigate the effect of sowing dates on the raw material (seed) yield of milk thistle under the irrigated gray soils of Samarkand Province and to identify the most suitable sowing time. Conducted over two growing seasons (2024–2025), the results provide a scientific basis for improving milk thistle cultivation practices.

Materials and Methods

Study Location. Field experiments were conducted in Payariq District, Samarkand Province, on a research farm. The trial site consisted of typical irrigated gray soils with a medium-heavy (loamy sand) texture. The subsoil had high carbonate content, and soil fertility was moderate. Soil analysis of the 0–30 cm layer showed ~1.2% humus, with 28 mg/ha phosphorus and 210 mg/ha potassium (moderately supplied soil). Climate Conditions. Samarkand Province has a temperate continental climate, with wet winters (rain and snow) and hot, dry summers. Weather during the trial years was close to long-term averages, with some variations. In 2024, spring-summer (March–June) precipitation totaled 78 mm, while in 2025, it reached 112 mm. Average April temperatures were 16.8°C in 2024 (maximum 28°C) and 15.5°C in 2025. July's hottest days in both years reached +38…+40°C. The wetter and cooler spring of 2025 positively influenced plant development. Experimental Design and Agro-technics. Three sowing date variants were tested: 1) Early sowing – March 15 (second decade of March); 2) Mid-term sowing – March 30 (third decade of March); 3) Late sowing – April 15 (second decade of April). Each variant was replicated three times, arranged in a randomized block design. Each plot was ~10 m², with the total experimental area covering ~0.1 ha. Sowing was done manually in rows, with 60 cm row spacing. Seeds were densely sown along rows and later thinned to 20–25 cm spacing (~6–8 plants per m²), resulting in ~60–70 thousand plants per hectare. The seed material, sourced from a local medicinal plant plantation (2023 harvest), had 85% germination.

Agro-technical measures were identical across variants. After plowing, the soil was cultivated in early spring. Before sowing, organic and mineral fertilizers were applied: 20 tons/ha of decomposed manure, 60 kg/ha superphosphate (P_2O_5), 40 kg/ha potassium sulfate (K_2O), and 60 kg/ha ammonium nitrate (N) were incorporated into the 0–20 cm soil layer. During the growing season, weeds were manually removed twice. Due to dry conditions, irrigation was applied three times: two weeks after seedling emergence, before flowering (late May), and during seed filling (late June). No pest or disease control measures were needed, as no infestations were observed. Measurements and Analysis. Plant development stages (germination, flowering, and ripening) were recorded. At the end of the growing season, five randomly selected plants per variant were measured for biometric indicators: average height, branching degree (number of lateral branches), and number of flower heads (capitula) per plant. Seeds were harvested when fully ripened (early July for variant 1, late July for variant 3), dried in shade, cleaned, weighed, and converted to tons per hectare. Data were analyzed using analysis of variance (ANOVA), with differences assessed at the $LSD_{0.05}$ significance level.

Results and Discussion

Plant Growth and Development. Sowing dates significantly affected early plant growth. Seeds sown early (March 15) germinated in 12–14 days, while late-sown seeds (April 15) germinated in 8–10 days due to warmer conditions. However, late-sown seedlings faced a shortened growth period and rising temperatures, limiting development. Early-sown plants completed a full vegetative cycle (~118 days), while the late-sown variant had a shorter cycle (~100 days). Notably, late-sown plants flowered two weeks later but ripened faster in July's heat, shortening the overall growth period and reducing vegetative mass accumulation.

Biometric Indicators. Sowing date variations led to significant differences in plant morphology. Early-sown plants were taller and more branched. Variant 1 plants averaged 122±3.5 cm in height, ~22% taller than variant 3. Early-sown plants produced 5–6 lateral branches, compared to 3–4 in the late-sown variant. Consequently, early-sown plants had more flower heads (10.3±0.6 per plant) compared to 7.5±0.4 in the late-sown variant. Flower head size and seed count also varied: early sowing produced larger heads with 80–120 seeds per head (due to better pollination and development conditions), while late sowing resulted in smaller heads with 60–80 seeds. These factors directly influenced seed yield.

Seed Yield. Over two years, milk thistle seed yield varied consistently with sowing dates. Average results for 2024 and 2025 are presented in Table 1.

【Table 1】Effect of Sowing Dates on Milk Thistle (S. marianum) Seed Yield (Samarkand, 2024–2025)

Sowing Date	2024 (t/ha)	2025 (t/ha)	Average (t/ha)
March 15 (early)	1.20	1.30	1.25
March 30 (mid)	1.05	1.10	1.08
April 15 (late)	0.84	0.92	0.88

Table 1. Sowing Date and Seed Yield. The early sowing variant (mid-March) consistently produced the highest yield in both years, while late sowing (mid-April) yielded the least. Yields in 2025 were slightly higher across all variants due to higher precipitation and more favorable climatic conditions.

The data shows that mid-March sowing is optimal for milk thistle in Samarkand Province. Early sowing yielded an average of 1.25 t/ha over two years, ~42% higher than the late-sown variant (0.88 t/ha). Mid-term sowing (late March) performed reasonably well but lagged behind early sowing by 0.17 t/ha (~16%). Yield differences between variants were statistically significant ($LSD_{0.05}$ = 0.11 t/ha, $p<0.05$).

Yearly analysis revealed higher yields in 2025 compared to 2024. For instance, variant 1 yielded 1.20 t/ha in 2024 and 1.30 t/ha in 2025, while variant 3 yielded 0.84 t/ha in 2024 and 0.92 t/ha in 2025. This was attributed to higher spring precipitation in 2025 (112 mm vs. 78 mm in 2024) and more stable temperatures, which improved soil moisture and plant development. In contrast, 2024 experienced early drought in late April and extreme heat in June, particularly affecting late-sown plants.

Delayed sowing negatively impacted yield due to a shortened vegetative period and reduced reproductive structures. Late-sown plants were shorter (~100 cm), less branched, and had fewer flower heads. Additionally, seeds from late-sown plants ripened during July's heat, resulting in smaller, lighter seeds, reducing overall yield. Early-sown plants benefited from cooler, wetter spring conditions, allowing better vegetative growth, more flower heads, and fully developed seeds, leading to higher yields.

Notably, sowing too early (e.g., late February) is not advisable in Samarkand due to late frosts and low soil temperatures, which delay germination. Mid-March was found optimal, as soil temperatures (5–10 cm depth) reach +8…+10°C, and moisture reserves are high, promoting uniform germination. The vegetative period aligns with favorable spring conditions, allowing plants to ripen by early summer. Late sowing shifts the vegetative period into the dry summer, reducing yield.

These findings align with international literature, which suggests optimal milk thistle growth occurs from early spring to mid-summer, with seed yields up to 1.5 t/ha under favorable conditions. The highest yield in this study (1.3 t/ha) is a strong result for Samarkand, compared to 0.5–0.8 t/ha reported in other Uzbek regions with lower moisture. Proper agro-technical measures in Samarkand can thus achieve high yields.

Conclusion

Field studies conducted in 2024–2025 on milk thistle (Silybum marianum L.) cultivation in Samarkand Province led to the following conclusions:

Sowing Date Impact on Yield: Early spring sowing (mid-March) ensured the highest seed yield. Delaying sowing to April shortened the growth period, significantly reducing yield. Early sowing averaged 1.25 t/ha over two years, while late sowing yielded 0.88 t/ha, a ~40% reduction.

Optimal Agro-technical Timing: The second decade of March was identified as the most suitable sowing time in Samarkand. Plants sown during this period fully utilized favorable climatic conditions, achieving optimal growth and high yields. Late March to early April sowing yielded acceptable results but was less productive. Mid-April sowing is not recommended. Yield Enhancement Opportunities: Early sowing, combined with timely agro-technical measures (adequate fertilization, irrigation, and weed control), was critical for maximizing yield. When plants were well-supplied with nutrients and water, seed yields aligned with the crop's biological potential, reaching 1.0–1.3 t/ha in Samarkand.

Practical Significance: These results provide a scientific basis for large-scale milk thistle cultivation in Samarkand Province. Adhering to optimal sowing dates can maximize seed yield, supporting Uzbekistan's pharmaceutical industry with high-quality local raw materials and reducing import dependency. The findings and recommendations can also guide milk thistle cultivation in other regions. In conclusion, mid-March is the most effective and productive sowing time for milk thistle in Samarkand Province. Early-sown plants benefit from optimal growth conditions, resulting in high yields. These findings can inform the development of agro-technical standards for milk thistle cultivation and contribute to expanding the medicinal raw material base and advancing Uzbekistan's pharmaceutical industry.

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