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INFLUENCE OF PLANTING SCHEMES ON THE YIELD OF ROMAINE LETTUCE (LACTUCA SATIVA VAR. LONGIFOLIA) CULTIVARS UNDER SPRING SOWING CONDITIONS IN UZBEKISTAN

Jahongir M. Mengniyozov,

Ravza F. Mavlyanova

Research Institute of Vegetable, Melon Crops and Potato, Uzbekistan

Corresponding author: mavlyanova.ravza@gmail.com

Annotation: The article presents the results of a study on lettuce cultivars conducted at the Research Institute of Vegetable, Melon Crops and Potato in Uzbekistan. The research examined romaine lettuce (Lactuca sativa var. longifolia) cultivars in comparison with a leafy lettuce (Lactuca sativa L.) during the spring sowing season under five planting schemes: 70×10 cm, 70×20 cm, 70×30 cm (control), 70×40 cm, and 70×50 cm. The experiment was arranged in a Randomized Complete Block Design (RCBD) with four replications. It was established that for the leafy lettuce cultivar Kok shokh, the planting scheme of 70×20 cm produced a yield of 1.76 kg/m² at 10% technical maturity, with plants characterized by tender leaves suitable for consumption. The optimal planting scheme for this cultivar was 70×30 cm, providing the highest yield of 1.95 kg/m². For the romaine lettuce cultivars Korolevskiy Pir and Quintus, the 70×20 cm scheme resulted in yields of 2.45–2.53 kg/m² with tender leaves from not yet fully developed plants. The optimal spacing for these cultivars was also 70×30 cm, at which the plant mass reached 624–641 g and the yield was 2.93 and 3.02 kg/m², respectively. Increasing the distance between plants in a row to 50 cm increased plant mass (675–697 g) but reduced overall yield by 22–35% due to lower plant density.

Keywords: plant density, planting scheme, plant weight, romaine lettuce, leafy lettuce, varieties, vegetation period, yield.

Introduction:

Optimization of planting schemes is one of the key factors influencing the yield of vegetable crops, including lettuce cultivated in open-field conditions. The spacing between plants determines stand density, growth intensity, biomass accumulation, and overall product quality.

Studies conducted in different countries have shown that increasing plant density up to a certain threshold can enhance yield; however, excessive crowding, on the contrary, reduces individual plant mass due to competition for resources (Hasan et al., 2017; Hamayoun et al., 2018). According to Moniruzzaman (2006), the highest lettuce yield (27.10 t/ha) was obtained with a 40×20 cm planting scheme combined with mulching, while at 40×30 cm the yield was lower. Similar results were reported by Pluato et al. (2023): at 20×40 cm, plants developed a well-formed leaf rosette, whereas at 20×20 cm, they produced only small bunches.

Research by Silva et al. (2000) indicated that the 20×20 cm spacing ensured a high marketable yield. According to Hamarash (2020), lettuce plants grown with 40 cm inter-row spacing had the highest plant mass (511.3 g), but the maximum yield (10,671.4 g/m²) was achieved with narrower spacing (10–15 cm). Comparable findings were confirmed by other authors (Zemichael et al., 2017; Gashaw et al., 2020).

In the experiments of Rizal et al. (2024), the application of the organic fertilizer “Kasgot” at different planting schemes for romaine lettuce positively affected the number of leaves, although no significant differences were observed in plant height or biomass.

Since romaine lettuce (Lactuca sativa var. longifolia) is a relatively new crop for Uzbekistan, determining the optimal plant density remains an important issue.

The objective of this study was to identify the most effective planting scheme for promising romaine lettuce cultivars under spring sowing conditions and to compare their productivity with that of a regionally adapted leafy lettuce cultivar. Field experiments were conducted during 2024–2025 at the Research Institute of Vegetable, Melon Crops and Potato in Uzbekistan.

Materials and Methods

The study included two promising romaine lettuce (Lactuca sativa var. longifolia) cultivars — Quintus (Netherlands) and Korolevskiy Pir (Russia) — as well as the regionally adapted leafy lettuce cultivar Kok shokh (Lactuca sativa L.) of Uzbek selection.

Sowing was carried out in the spring using 30-day-old seedlings grown under greenhouse conditions. Transplanting to open-field plots was performed during the first ten days of April. The experimental site soils were classified as typical sierozems, characteristic of the region where the study was conducted. Climatic conditions were marked by a gradual increase in air temperature from +15°C in April to +31°C in June. Spring precipitation was minimal; therefore, furrow irrigation was applied to ensure a stable water supply for the plants.

Five planting schemes were evaluated: 70×10 cm, 70×20 cm, 70×30 cm (control), 70×40 cm, and 70×50 cm. The experiment was arranged in a Randomized Complete Block Design (RCBD) with four replications to minimize environmental variation and improve the reliability of the results. Observations included the recording of phenological phases, measurement of biometric parameters (rosette height, number of leaves, and plant mass), and determination of yield depending on planting scheme. The experimental procedures and data collection followed standard methodologies described in established manuals (Azimov et al., 2002; Nizomov, 2023; Dospekhov, 1985).

Results and Discussion

Vegetation Period

Field observations demonstrated that planting schemes had a pronounced effect on the growth rate, plant development, and the timing of technical maturity. Differences were observed among cultivars for both 10% and 75% maturity stages.

Under the densest planting (70×10 cm), seedlings of the leafy lettuce cultivar Kok shokh initially established satisfactorily but soon exhibited markedly slower growth. Excessive competition for light and nutrients hindered normal development: plants remained stunted, produced few leaves, and did not reach even 10% maturity.

At 70×20 cm spacing, plant growth remained weak; 10% maturity was recorded only on the 48th day after emergence, while 75% maturity was not achieved. In the control treatment (70×30 cm), plants reached 10% maturity on the 41st day and 75% maturity on the 53rd day. Under wider spacing (70×40 and 70×50 cm), plants exhibited similar timing but formed well-developed leaf rosettes approximately 30 cm high.

For the Quintus cultivar, plant growth was also restricted under dense planting (70×10 cm), and development practically ceased once the leaves overlapped. At 70×20 cm spacing, plants reached 10% maturity on the 62nd day but did not progress further. The most favorable results were obtained at 70×30 cm, where 10% and 75% maturity occurred on the 57th and 72nd days after emergence, respectively. Plants grown at 70×40 and 70×50 cm spacing also developed uniformly and maintained steady growth rates.

The Korolevskiy Pir cultivar exhibited similar patterns. Under the densest spacing (70×10 cm), plants were severely stunted and did not reach maturity; at 70×20 cm, 10% maturity occurred on the 37th day, while 75% maturity was not achieved. The 70×30 cm scheme proved the most favorable, ensuring 10% maturity on the 63rd day and 75% maturity on the 68th day. Increasing the interplant distance to 40–50 cm maintained comparable developmental dynamics, confirming sufficient nutrition area for proper growth.

Thus, for all cultivars tested, an interplant spacing of at least 30 cm ensured balanced growth rates and uniform development without signs of suppression.

Yield Performance

The experiments revealed significant differences in plant mass and yield among lettuce cultivars depending on the planting scheme. The effect of stand density was consistent across all variants, with similar tendencies for both leafy and romaine lettuce types.

Cultivar Kok shokh. At the densest spacing (70×10 cm), plants of the leafy lettuce Kok shokh developed poorly. The rosette height did not exceed 10–12 cm; leaves were small, pale green, and the plant mass averaged only 76 g. Due to inhibited growth, the yield was the lowest among others (1.08 kg/m²), and the harvested product was non-marketable. At 70×20 cm spacing, growth improved: average plant mass increased to 251 g, and yield reached 1.76 kg/m². At this stage, plants formed young, tender, bright-green leaves suitable for consumption. The control scheme (70×30 cm) ensured the best development: plants formed large rosettes (24–26 cm high), with an average mass of 363 g and a yield of 1.95 kg/m². Further widening of spacing (70×40 and 70×50 cm) slightly increased plant mass (to 380–392 g) but reduced yield (to 1.38–1.21 kg/m²) due to lower plant density. Therefore, for Kok shokh, the 70×30 cm scheme was identified as optimal, combining marketable quality, plant mass, and maximum productivity (Table 1).

Cultivar Quintus. Under dense planting (70×10 cm), Quintus plants formed small rosettes 11–14 cm tall, with an average mass of about 91 g. Growth ceased shortly after canopy closure, resulting in low biomass and a yield of 1.27 kg/m². At 70×20 cm spacing, growth conditions improved: plants formed 15–18 cm high rosettes with a mass of 350 g and a yield of 2.53 kg/m². Leaves at this stage were tender and had favorable taste characteristics. The best results were observed at 70×30 cm spacing. Under these conditions, plants formed vigorous rosettes 25–28 cm high, with an average mass of 641 g and a yield of 3.02 kg/m². Further widening to 70×40 and 70×50 cm increased plant mass to 668–697 g but reduced yield to 2.37–2.01 kg/m² due to reduced stand density.

Table 1. Average plant mass and yield of lettuce cultivars under different planting schemes

Planting scheme	**Plant mass, g**			**Yield, kg/m²**		
	Kok shokh (control)	Quintus	Korolevskiy Pir	Kok shokh (control)	Quintus	Korolevskiy Pir
70x10 cm	76	91	85	1, 08	1,27	1,19
70×20 cm	251	350	334	1,76	2,53	2,45
70×30 cm (control)	363	641	624	1,95	3,02	2,93
70×40 cm	380	668	638	1,38	2,37	2,18

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70×50 cm	392	697	675	1,21	2,01	1,94
LSD_{05}	14,5	17,4	20,7	0,06	0,09	0,07
$S_{x\%}$	4,8	3,6	4,4	4,2	4,1	3,1

Cultivar Korolevskiy Pir. The Korolevskiy Pir cultivar showed a response similar to that of Quintus. Under dense planting (70×10 cm), plants grew slowly, with a mass of 85 g and a yield of 1.19 kg/m². At 70×20 cm spacing, growth improved, plant mass reached 334 g, and yield increased to 2.45 kg/m². Although plants did not reach full technical maturity, they were suitable for harvest and characterized by a dark-green color with reddish pigmentation, soft texture, and good market quality. The maximum yield of 2.93 kg/m² was recorded at 70×30 cm spacing, where plants had an average mass of 624 g. Increasing spacing to 70×40 and 70×50 cm enhanced individual plant mass (638–675 g), but yield decreased to 2.18–1.94 kg/m², respectively.

The analysis revealed a direct correlation between average plant mass and yield (Figure 1). As planting density increased, the mass of individual plants decreased, whereas under wider spacing, plant mass increased. However, overall productivity per unit area declined under sparse planting due to reduced plant density.

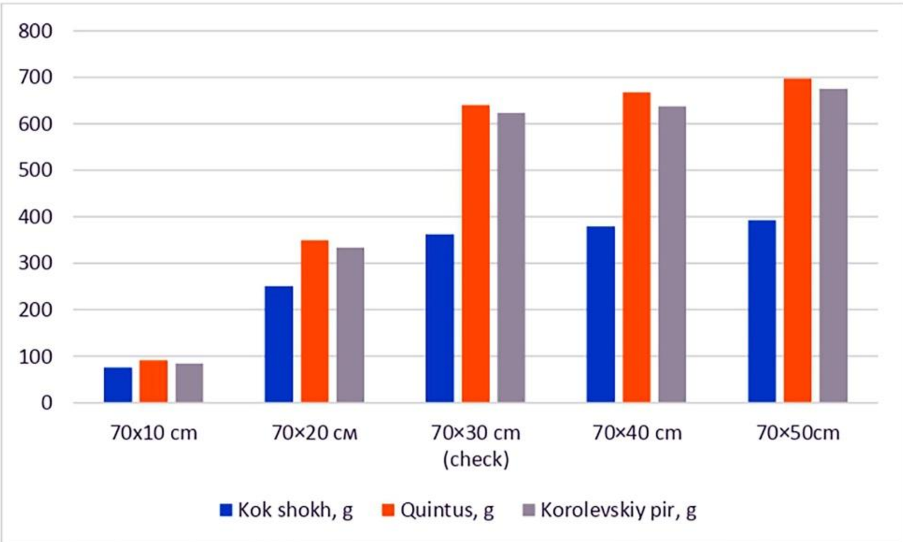

Fig. 1. Effect of planting scheme on plant mass of lettuce cultivars.

The graph illustrates the dynamic change in plant mass depending on the planting scheme. For all cultivars studied, a similar pattern was observed: as spacing widened, plant mass increased, but beyond the optimal 70×30 cm arrangement, further widening led to yield reduction.

The findings confirm that the planting scheme has a decisive influence on lettuce growth, development, and productivity. Under dense spacing (70×10 cm), plants of all cultivars exhibited weak growth, with plant mass not exceeding 76–91 g and leaves being small, often deformed, and non-marketable. At 70×20 cm spacing, plants reached 10% technical maturity and produced tender, marketable leaves, but the limited nutrition area prevented full growth potential.

The 70×30 cm scheme proved optimal for all cultivars, producing average plant masses of 363 g (Kok shokh), 641 g (Quintus), and 624 g (Korolevskiy Pir) and the highest yields of 1.95–3.02 kg/m².

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Further widening of plant spacing (up to 40–50 cm) enhanced individual plant development but reduced total yield by 22–35% due to decreased stand density. Thus, an inverse relationship was observed between plant mass and overall yield: higher density reduced individual plant mass, but up to a certain threshold, total productivity increased. For the cultivars studied, the 70×30 cm scheme provided the optimal balance between plant mass and density, ensuring stable growth, marketable quality, and efficient land use.

Conclusion

The conducted research confirmed the significant influence of planting schemes on the growth, development, and yield of lettuce cultivars grown during the spring season under the conditions of Uzbekistan. Optimization of plant density proved to be a key factor determining both biometric parameters and the quality of the harvested product.

Excessive plant crowding (70×10 cm) resulted in growth suppression, delayed attainment of technical maturity, and the formation of small, non-marketable plants. At 70×20 cm spacing, plant development improved and 10% technical maturity was achieved; however, the limited nutrition area prevented full growth potential from being realized.

The most favorable conditions were achieved under the 70×30 cm planting scheme. In this variant, plants developed uniformly and demonstrated the highest plant mass and yield. The Kok shokh cultivar yielded 1.95 kg/m² with an average plant mass of 363 g, Quintus — 3.02 kg/m² and 641 g, and Korolevskiy Pir — 2.93 kg/m² and 624 g, respectively.

Increasing interplant spacing to 70×40 cm and 70×50 cm promoted further growth of individual plants but reduced overall yield per area due to decreased plant density.

Therefore, the 70×30 cm planting scheme is recommended as optimal for both leafy and romaine lettuce under spring growing conditions in Uzbekistan. It ensures efficient land use, uniform plant development, high marketable quality, and stable productivity of commercial yield.

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