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Issue Article

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EFFECT OF DIFFERENT SOWING DATES AND PLANTING PATTERNS ON THE GROWTH AND DEVELOPMENT OF PEA (PISUM SATIVUM L.) VARIETIES

Abstract: *A field study was conducted under the conditions of long-cultivated, irrigated typical sierozem soils in Kashkadarya Region, Uzbekistan, to investigate the growth and development of forage pea (Pisum sativum L.) varieties sown at different dates and using different planting patterns. Sowing was carried out on 10, 20, and 30 October. The results showed that seed emergence was delayed by 3–5 days as the sowing date was postponed. Nevertheless, the average field emergence rate across all varieties was 99.8%. Increasing the area available to individual plants by changing the planting pattern from the control spacing of 60x20 cm to 60x25 cm and 60x30 cm positively affected the development of generative organs and prolonged the flowering and pod-setting phases by 2–5 days. The flowering and pod-setting periods of the Vostok-55 and K-295 varieties differed by several days from those of Osiyo-2001, influencing the overall duration of the growing season. In the treatments sown on 10 October, the growing season lasted an average of 217–230 days, providing favorable conditions for plant growth and development. These findings may be associated with more active development of vegetative and generative organs under wider plant-spacing arrangements.*

Key words: *forage pea, pea, variety, sowing date, planting pattern, plant nutritional area, field emergence, phenological phases, plant growth dynamics, growing season, generative organs, typical sierozem soils, agricultural technology.*

Language: *English*

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Introduction

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The continuous growth of the global population and the increasing demand for protein-rich plant products, environmentally sustainable food, and high-quality feed for livestock have made the cultivation of forage pea increasingly important. Owing to its high content of protein, starch, vitamins, and minerals, pea is an important raw material for the food industry and livestock production.

Previous studies have shown that forage pea varieties differ in their responses to sowing dates and that interactions between varietal biological characteristics and environmental conditions play an important role in yield formation. This highlights the

need to evaluate individual varieties not according to a single, universally applied sowing date, but with due consideration of their biological characteristics [1–3, 5, 11, 12, 14–24]. At the same time, improving pea cultivation technologies, scientifically determining the effects of sowing dates and planting patterns on productivity, and developing agronomic practices that ensure high and good-quality seed yields are important scientific and practical objectives.

Therefore, further research into the production of forage pea varieties for seed purposes, together with the development and recommendation of innovative agricultural technologies to increase productivity, establishes the relevance and practical necessity of this research.

Research objective

The objective of this study was to provide a scientific basis for improving the cultivation practices used to grow forage pea varieties for green manure and seed production under the conditions of long-cultivated, irrigated typical sierozem soils in Yakkabog District, Kashkadarya Region, Uzbekistan, using different sowing dates and planting patterns, with the aim of obtaining high-quality seed and grain yields.

Research objects

The research objects were long-cultivated, irrigated typical sierozem soils in Kashkadarya Region and three forage pea varieties: Osiyo-2001, Vostok-55 and K-295.

Research subject

The research focused on the growth and development of forage pea varieties cultivated for seed production under different sowing dates and planting patterns; grain yield; leaf area and the accumulation of biological dry matter; the effects of cultivation practices on the soil's agrophysical, agrochemical, hydrological, and microbiological properties; and the potential for obtaining grain and seed yields.

Research conditions, materials, and methods

Field experiments were conducted for the first time during 2023–2026 under the conditions of long-cultivated, irrigated typical sierozem soils at the Uyghur and Zafar farms in Yakkabog District, Kashkadarya Region, Uzbekistan. Groundwater was located at a depth of 8–12 m. The soil had a medium-loamy texture.

In the 0–30 cm plough layer, the humus content was reported as 1.0–1.8%. The soil bulk density ranged from 1.27 to 1.30 g/cm³, and particle density ranged from 2.58 to 2.65 g/cm³. Total nitrogen content was 0.094–0.095%, total phosphorus 0.144–0.163%, and potassium 2.6–2.9%. Nitrate nitrogen content ranged from 5.14 to 6.51 mg/kg, available phosphorus from 8 to 17 mg/kg, and exchangeable potassium from 156 to 193 mg/kg.

Soil analyses indicated a slightly acidic reaction, with pH values ranging from 5.9 to 6.7. The concentrations of these nutrients were found to be somewhat lower in the subsoil layer than in the plough layer.

During the 2023–2026 field experiments, the research was conducted on long-cultivated, irrigated typical sierozem soils in Yakkabog District, using the autumn-sown forage pea varieties Osiyo-2001 and Vostok-55, which are included in the State Register, together with the K-295 variety (Table 1).

Field experiments were established to address the research objectives and tasks. The experiments were conducted in three replications in accordance with B. A. Dospekhov's Methodology of Field Experiment.

The following experimental factors were studied:

Varieties (3): Osiyo-2001, Vostok-55, and K-295.

Sowing dates (3): 10 October, 20–21 October, and 30–31 October.

Planting patterns (3): 60 × 20 cm, 60 × 25 cm, and 60 × 30 cm.

The experiment comprised 27 treatment combinations (3 varieties × 3 sowing dates × 3 planting patterns).

Table 1. Experimental design

Sowing date	Planting pattern, cm	Variety
10 October	60 × 20 (control)	Osiyo-2001, Vostok-55, K-295
20–21 October	60 × 25	Osiyo-2001, Vostok-55, K-295
30–31 October	60 × 30	Osiyo-2001, Vostok-55, K-295

Experimental plot layout and dimensions

The area allocated to each experimental plot was 24 m², with a length of 20.0 m and a width of 1.2 m. Each plot consisted of two rows, with a row spacing of 60 cm and within-row plant spacing determined by the assigned planting pattern.

Each treatment was replicated three times, giving a total area of 72 m² per treatment (3 × 24 m²). The experiment included 81 plots in total (27 treatments × 3 replications).

The total net experimental area required for the 27 treatments was 1,944 m², equivalent to approximately 0.2 ha.

Forage pea varieties were sown in autumn on 10, 20–21, and 30–31 October at a depth of 5–6 cm.

Seed rates for different planting patterns

The calculated and practical seed rates per hectare were determined based on the 1,000-seed weight of each variety—200 g for Vostok-55, 165 g for Osiyo-2001, and 170 g for K-295—taking field emergence and a reserve allowance into account.

1. Planting pattern of 60 × 20 cm

Calculated stand density: approximately 83,300 plants/ha.

Vostok-55 (1,000-seed weight: 200 g): 175–180 kg/ha.

Osiyo-2001 (1,000-seed weight: 165 g): 145–150 kg/ha.

K-295 (1,000-seed weight: 170 g): 150–155 kg/ha.

2. Planting pattern of 60 × 25 cm

Calculated stand density: approximately 66,700 plants/ha.

Vostok-55: 140–145 kg/ha.

Osiyo-2001: 115–120 kg/ha.

K-295: 120–125 kg/ha.

3. Planting pattern of 60 × 30 cm

Calculated stand density: approximately 55,600 plants/ha.

Vostok-55: 115–120 kg/ha.

Osiyo-2001: 95–100 kg/ha.

K-295: 100–105 kg/ha.

Sowing was carried out using SZ-3.6 and SZA-3.6 seed drills [11]. The drills were adjusted to the required planting patterns before sowing the Vostok-55, Osiyo-2001, and K-295 varieties. Each variety was sown in two rows in each experimental plot [11, 13].

Before sowing, mineral fertilizers were applied at rates of $N_{30}P_{100}K_{75}$ kg/ha. The autumn-sown forage pea varieties received an additional nitrogen application of N_{30} in early spring. Following sowing, irrigation was applied at a rate of 450–500 m³/ha. The autumn-sown pea crop was irrigated three times, including two irrigations in spring. The experimental design is presented in Table 2.

Experiment 1. Evaluation of forage pea varieties sown in autumn using different sowing dates and planting patterns.

Table 2. Experimental treatment combinations

Variant	Sowing date	Sowing pattern (cm)	Variety
1	10 October	60 × 20 (control)	Osiyo-2001
2	10 October	60 × 25	Osiyo-2001
3	10 October	60 × 30	Osiyo-2001
4	20–21 October	60 × 20 (control)	Osiyo-2001
5	20–21 October	60 × 25	Osiyo-2001
6	20–21 October	60 × 30	Osiyo-2001
7	30–31 October	60 × 20 (control)	Osiyo-2001
8	30–31 October	60 × 25	Osiyo-2001
9	30–31 October	60 × 30	Osiyo-2001
10	10 October	60 × 20 (control)	Vostok-55
11	10 October	60 × 25	Vostok-55
12	10 October	60 × 30	Vostok-55
13	20–21 October	60 × 20 (control)	Vostok-55
14	20–21 October	60 × 25	Vostok-55
15	20–21 October	60 × 30	Vostok-55
16	30–31 October	60 × 20 (control)	Vostok-55
17	30–31 October	60 × 25	Vostok-55
18	30–31 October	60 × 30	Vostok-55
19	10 October	60 × 20 (control)	K-295
20	10 October	60 × 25	K-295
21	10 October	60 × 30	K-295
22	20–21 October	60 × 20 (control)	K-295
23	20–21 October	60 × 25	K-295
24	20–21 October	60 × 30	K-295
25	30–31 October	60 × 20 (control)	K-295
26	30–31 October	60 × 25	K-295
27	30–31 October	60 × 30	K-295

Research methods

Laboratory, field, and on-farm experiments were conducted, together with phenological observations and analyses of physiological and biometric indicators. The work was based on the following methodological publications:

Methods of Conducting Field Experiments; Scientific Research in Plant Production; Methods of State Variety Testing of Agricultural Crops; Photosynthetic Activity of Plants in Crops; Methods of Agrochemical, Agrophysical, and Microbiological Research in Irrigated Cotton-Growing Areas; Methods of Agrochemical Analysis of Soils and Plants in Central Asia; Basic Principles for Determining the Economic Efficiency of Using Research Results, New Technology, Inventions, and Rationalization Proposals in Agriculture. The experimental data were subjected to mathematical and statistical analysis using Microsoft Excel according to the method of B.A.Dospekhov [2, 4, 6–8, 10, 13].

Research results

Phenological development of forage pea varieties

According to the phenological observations, in the treatments sown on 10 October, 10% emergence was recorded on 13–15 October, while 75% emergence was observed on 16–18 October. Although emergence in the treatments sown on 20 and 30 October was delayed by 3–5 days, no substantial differences in the emergence process were observed among varieties or planting patterns.

The budding phase began during the first ten days of March, on 2–5 March, and lasted 19–22 days depending on the variety and treatment. The main differences in phenological development became apparent during flowering. The flowering phase lasted 24–27 days in Osiyo-2001, 26–30 days in Vostok-55, and 26–29 days in K-295.

The pod-setting and seed-formation phases became longer as the planting pattern widened. Under the 60 × 30 cm planting pattern, flowering and pod-setting lasted 2–5 days longer than in the control treatment with a spacing of 60 × 20 cm. This may be associated with the greater area available to each plant, which can promote the development of vegetative and generative organs.

Stem yellowing and full seed maturity within the pods occurred from the second half of May to early June, depending on the variety and sowing date. The total growing season averaged 217–230 days in treatments sown on 10 October, 208–223 days in treatments sown on 20 October, and 198–212 days in treatments sown on 30 October (Table 3).

Phenological observations and biometric measurements indicated that field emergence was high in all varieties, averaging 99.8%. This high value was attributed in the original study to harvesting the seeds at full physiological maturity, a relatively short storage period of 2–3 months, annual renewal of the seed material, and selection according to quality indicators before sowing. These factors were considered to help maintain seed viability and germination energy, resulting in uniform and rapid emergence under field conditions.

The observations also showed that, when Osiyo-2001 was sown on 10 October 2023 using the 60 × 30 cm planting pattern, the flowering phase lasted 27 days, pod setting and seed formation lasted 22 days, and the total growing season lasted 222 days. Compared with the control treatment, flowering was 3 days longer, pod setting was 1 day longer, and the total growing season was 5 days longer.

Table 3. Phenological observations of autumn-sown forage pea varieties under different sowing dates and planting patterns (mean values for 2023–2026)

№	Sowing date	Planting pattern (cm)	Plants/ha (thousand)	Sowing depth (cm)	Field emergence (%)	Emergence	True leaves	Stem formation	Budding	Flowering	Pod setting	Maturity	Growing season
	Variety Osiyo-2001												
1	10 Oct	60x20 (control)	83.3	5	99.8	6	6	16	21	24	19	21	217
2	10 Oct	60x25	66.7	5	99.8	6	6	15	22	26	19	22	220
3	10 Oct	60x30	55.5	5	99.8	6	6	15	22	27	21	22	222
	Variety Vostok-55												
1	10 Oct	60x20 (control)	83.3	6	99.8	7	7	16	19	26	24	23	225

2	10 Oct	60x25	66.6	6	99.8	7	7	15	22	28	26	22	227
3	10 Oct	60x30	55.5	6	99.8	7	7	15	22	30	29	22	230
	Variety K-295												
1	10 Oct	60x20 (control)	83.3	5	99.8	7	6	16	19	26	24	22	225
2	10 Oct	60x25	66.6	5	99.8	7	6	15	22	28	25	22	227
3	10 Oct	60x30	55.5	5	99.8	7	6	15	22	29	28	22	230
	Variety Osiyo-2001												
1	20 Oct	60x20 (control)	83.3	5	99.8	7	6	16	19	26	20	21	211
2	20 Oct	60x25	66.6	5	99.8	7	6	15	22	27	20	22	214
3	20 Oct	60x30	55.5	5	99.8	7	6	15	22	28	22	22	217
	Variety Vostok-55												
1	20 Oct	60x20 (control)	83.3	6	99.8	8	6	16	19	28	26	23	219
2	20 Oct	60x25	66.6	6	99.8	8	6	15	22	29	27	24	222
3	20 Oct	60x30	55.5	6	99.8	8	6	15	22	31	27	24	223
	Variety K-295												
1	20 Oct	60x20 (control)	83.3	5	99.8	8	6	16	19	28	26	22	218
2	20 Oct	60x25	66.6	5	99.8	8	6	15	22	29	27	23	221
3	20 Oct	60x30	55.5	5	99.8	8	6	15	22	31	27	23	222
	Variety Osiyo-2001												
1	30 Oct	60x20 (control)	83.3	5	99.8	7	7	15	19	26	18	24	201
2	30 Oct	60x25	66.6	5	99.8	7	7	14	22	27	18	25	204
3	30 Oct	60x30	55.5	5	99.8	7	7	14	22	28	20	25	206
	Variety Vostok-55												
1	30 Oct	60x20 (control)	83.3	6	99.8	8	7	15	19	28	23	26	208
2	30 Oct	60x25	66.6	6	99.8	8	7	14	22	29	24	28	211
3	30 Oct	60x30	55.5	6	99.8	8	7	14	22	31	24	27	212
	Variety K-295												
1	30 Oct	60x20 (control)	83.3	5	99.8	8	7	15	19	27	21	26	206
2	30 Oct	60x25	66.6	5	99.8	8	7	14	22	28	22	27	209
3	30 Oct	60x30	55.5	5	99.8	8	7	14	22	30	23	26	210

Overall, the phenological observations showed that sowing date and planting pattern substantially influenced the growth and development of pea varieties. In particular, widening the planting pattern to 60 × 25 cm or 60 × 30 cm created conditions that were more favorable for biological development and the formation of generative organs, and was associated with a longer growing season.

Thus, the results confirmed that sowing dates and planting patterns significantly affected the duration of growth and developmental stages of forage pea varieties under long-cultivated, irrigated typical sierozem soil conditions. Earlier sowing, particularly on 10–20 October, was associated with a longer growing season and favorable conditions for the completion of generative phases. Wider planting patterns of 60 × 25 cm and 60 × 30 cm prolonged flowering and pod-setting phases. In contrast, the phenological stages progressed more rapidly in the late-sown treatments of 30 October, where the growing season was shorter. These findings indicate that selecting appropriate sowing dates and planting patterns, while accounting for the biological characteristics of each variety, is an important agronomic factor in managing the phenological development of pea.

The results also demonstrated that sowing dates and planting patterns, particularly the area available to

each plant, significantly affected plant height and its changes across phenological stages (Table 4).

Table 4. Plant height of pea varieties at different phenological stages under different sowing dates and planting patterns (mean values for 2023–2026)

№	Planting pattern (cm)	Sowing date	Before wintering	Stem formation and branching	Budding	Flowering	Pod setting	Seed formation in pods	Before stem yellowing
	Variety Osiyo-2001								
1	60x20 (control)	10.10.	37,1	42,8	67,7	110,2	187,9	249,0	261,3
2	60x25		35,5	40,5	65,5	100,2	179,6	243,0	248,0
3	60x30		35,3	39,6	62,8	96,5	177,6	234,0	238,0
	Variety Vostok-55 navi								
1	60x20 (control)	10.10.	36,9	41,8	64,8	104,1	183,0	240,3	246,1
2	60x25		35,2	39,6	63,0	99,6	174,2	234,8	239,0
3	60x30		34,0	37,7	59,2	95,0	166,1	228,9	233,0
	Variety K-295 navi								
1	60x20 (control)	10.10.	36,8	41,6	64,3	105,1	182,5	239,6	247,4
2	60x25		35,3	39,1	62,6	99,4	173,7	233,7	238,2
3	60x30		33,6	37,4	59,0	94,8	165,7	228,4	232,0
	Variety Osiyo-2001 navi								
1	60x20 (control)	20.10.	31,6	40,2	62,5	108,5	186,7	237,7	244,4
2	60x25		29,4	37,1	59,7	100,0	178,2	230,7	234,7
3	60x30		27,7	35,2	56,4	96,0	172,2	226,4	230,0
	Variety Vostok-55 navi								
1	60x20 (control)	20.10.	31,5	39,0	62,2	102,2	181,4	233,0	237,7
2	60x25		30,5	36,6	59,2	95,5	172,2	220,4	223,1
3	60x30		28,5	34,1	57,3	91,1	164,6	218,0	220,7
	Variety K-295 navi								
1	60x20 (control)	20.10.	31,7	38,1	62,4	101,9	179,8	229,1	234,3
2	60x25		30,2	36,7	59,1	95,2	166,2	220,3	225,3
3	60x30		28,4	33,9	57,0	92,1	159,5	217,4	219,7
	Osiyo-2001 navi								
1	60x20 (control)	30.10.	28,5	35,0	59,6	100,5	178,5	227,2	234,7
2	60x25		26,8	32,6	57,7	97,0	174,2	218,9	222,6
3	60x30		24,6	28,9	55,3	92,8	169,9	216,4	218,8
	Variety Vostok-55 navi								
1	60x20 (control)	30.10.	28,7	34,1	62,2	101,3	177,2	226,3	231,8
2	60x25		27,1	32,1	58,6	99,0	171,6	218,7	221,6
3	60x30		25,4	29,4	56,6	96,8	167,0	216,6	218,2
	Variety K-295 navi								
1	60x20 (control)	30.10.	28,5	33,3	60,8	100,1	177,2	225,9	231,0
2	60x25		26,3	31,2	58,0	97,6	170,3	219,1	221,1
3	60x30		25,1	28,2	55,2	94,6	166,5	216,4	217,8

The multi-year study conducted during 2023–2026 on long-cultivated, irrigated typical sierozem soils in Yakkabog District, Kashkadarya Region, showed that the growth dynamics of forage pea varieties were closely associated with sowing date, plant nutritional area, and the biological characteristics of each variety.

The results indicated that plants in the treatments sown early, on 10 October, entered the winter

dormancy period in a relatively well-developed condition.

Before wintering, the average plant height was 35.3–37.1 cm for Osiyo-2001, 34.0–36.9 cm for Vostok-55, and 33.6–36.8 cm for K-295. When sowing was delayed until 20 or 30 October, the shorter autumn growing period was associated with reduced plant height before winter. The original text reports values of 31.6–24.6 cm, 25.4–31.5 cm, and 25.1–31.7 cm for the respective sowing-date comparisons; these ranges should be checked against the original observations before publication.During stem formation and branching in early spring, plant growth continued. In the treatments sown on 10 October, plant height across the varieties ranged from 37.4 to 42.8 cm. In the late-sown treatments of 30 October, this indicator ranged from 28.2 to 35.0 cm. The original study attributed the difference to the fact that plants sown at the more favorable dates had more time to develop their root systems and vegetative organs during autumn.

Conclusions

1. Under the conditions of long-cultivated, irrigated typical sierozem soils in Yakkabog District, Kashkadarya Region, the 2023–2026 study found that the average field emergence rate of the Osiyo-2001, Vostok-55, and K-295 forage pea varieties was 99.8%. Delaying sowing from 10 October to 20–21 October and 30–31 October affected the timing of seed emergence, with emergence occurring 3–5 days later in the later-sown treatments.

2. Changing the planting pattern from the control spacing of 60 × 20 cm to 60 × 25 cm and 60 × 30 cm influenced the phenological development of the plants. In particular, under the 60 × 30 cm pattern, flowering and pod-setting phases were prolonged by 2–5 days compared with the control. This was associated with the greater area available to individual plants and suggested more favorable conditions for the development of generative organs.

3. The interaction between sowing date and planting pattern was reflected in the duration of the growing season and the formation of plant height. The growing season lasted 217–230 days in the treatments sown on 10 October, 211–223 days in those sown on 20 October, and 201–212 days in those sown on 30 October. Plants in the earlier-sown treatments were also relatively taller before wintering. These findings indicate that, under the conditions of Kashkadarya Region, selecting sowing dates and plant nutritional areas according to the biological characteristics of each pea variety is an important agronomic factor.

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