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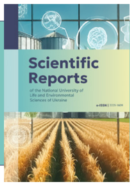


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# Growth and development of asparagus bean varieties about plant density

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**Abstract.** The growth, development, and productivity of cowpeas are influenced by soil and climatic conditions, as well as cultivation techniques, particularly the optimal stand density, which requires scientific validation for the conditions of the Right-Bank Forest-Steppe of Ukraine. This research aimed to study the characteristics of growth and development of Vigna about stand density, to optimise the productivity of different varieties. Research methods included field experiments to study cultivation techniques and statistical analysis to evaluate the reliability of the results. The study, conducted between 2014 and 2016, examined the effect of standing density on two cowpea varieties (U-Cha-Kontou and Kafedralna) using four planting schemes (70×10 cm, 70×25 cm, 70×40 cm, 70×50 cm). It was found that standing density significantly affects the growth, development, phenology, and productivity of Vigna. Field germination rates ranged from 80.0% to 85.1% across the variants studied. It was noted that an increase in the sowing rate reduced the field germination of the varieties' seeds. Differences in plant survival rates during the growing season were observed among the varieties. Extreme values of this indicator ranged from 83.6% to 87.8% for the U-Cha-Kontou variety, and from 87.7% to 91.0% for the Kafedralna variety. At a standing density of 29,000-36,000 plants per hectare, the onset of flowering

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in both varieties occurred later (24-27 June). Furthermore, the phases of flowering onset and fruit ripening were observed 2-3 days earlier than the control and the period from emergence to flowering lasted 46-51 days. The U-Cha-Kontou and Kafedralna varieties reached biological maturity on 27 and 22 August, respectively, at a standing density of 29,000-36,000 plants per hectare. The precocious plants were found in denser sowings of 143,000 plants per hectare, where the varieties' growing season lasted 135-141 days. The research findings could be valuable for practical use by vegetable growers, breeders, and specialists interested in vegetable cultivation, storage, and processing

**Keywords:** sowing schemes; field germination; plant survival rate; growth and development phases; technical maturity; beans

## Introduction

The growth and development of cowpeas, as well as other vegetable crops, depend on soil and climatic conditions, which influence the crops' responses. At the same time, the duration of phenological phases and plant productivity are determined not only by soil and climate conditions but also by cultivation techniques. Key technological measures that contribute to optimal plant growth and development, and improved yields, include the selection of an appropriate sowing rate and plant spacing. These factors help create favourable conditions for cultivating asparagus beans.

H. Ishikawa *et al.* (2022) investigated that for leguminous crops such as *Vigna* and soybeans, planting density is particularly important, as once the seedlings emerge, the plants begin to compete with each other. Therefore, to achieve maximum yield, planting density needs to be regulated. D. Gustiningsih *et al.* (2023) described that sowing one seed per planting hole reduces competition between plants, allowing them to grow faster than when sowing more seeds.

Moreover, J.A. Adigun *et al.* (2020) noted that one approach to improving the competitiveness of crops against weeds is to reduce the row spacing. Narrower row spacing suppresses weed germination and growth, giving the crop a competitive advantage primarily through quicker canopy closure. *Vigna* typically develops full canopy cover around six weeks after emergence, allowing them to compete with weeds until maturity.

According to M. Monteiro *et al.* (2017), the larger the plant population, the lower the siliquae productivity per plant. This is attributed to high inter- and intra-plant competition at higher population densities, which leads to flower abortion and a reduction in the number of lateral branches. M.J. Cardoso *et al.* (2018) concluded that the number of siliquae per plant responds linearly to increasing plant density, indicating that for each additional plant per square metre, the number of siliquae per plant decreased by 0.213 for upright varieties, 0.166 for semi-erect varieties, and 0.378 for semi-prostrate varieties.

In the study by T. Nevhulaudzi *et al.* (2020), it was noted that plants in the flowering/early anthesis stage exposed to elevated temperatures (35°C) exhibited the greatest reduction in biomass (47% in fresh weight and 63% in dry weight) compared to plants exposed to the same temperature at other growth stages (42% and 29% in the pre-flowering phase and 1% and 0% in the post-flowering phase). According to H. Bergamaschi & J. Bergonci (2017), increased temperatures are associated with accelerated growth and phenology. As a result, when plants encounter stressful growing conditions, they alter their metabolic processes to ensure optimal growth and development. The rate at which these processes occur is influenced by the plant's stress response, which leads to increased respiration.

L.M. Nderi (2020) determined that for agricultural producers aiming to maximise the biomass yield of *Vigna*, it is advisable to follow a sowing scheme of 60x20 cm. To achieve maximum grain yield of *Vigna* in Kilifi County, the KVU 27-1 variety is recommended with a 40x20 cm sowing scheme. In the conditions of southeastern Brazil, R.P. Soratto *et al.* (2020) concluded that the highest seed yield of *Vigna* was achieved at a stand density ranging from 216,630 to 290,537 plants per hectare (8-24% higher than the lowest density of 100,000 plants/ha). According to K. Giridhar *et al.* (2020), a sowing scheme of 20x30 cm (166,666 plants/ha) can be selected for growing *Vigna* in the sandy loam soils of Gajapati District, Odisha, as it produced higher grain yields compared to the 10×30 cm (333,333 plants/ha) and 15x30 cm (222,222 plants/ha) schemes.

E.B. Kouam *et al.* (2018) found that the adaptation of varieties can vary significantly across different environments. Breeders aim to develop varieties capable of withstanding adverse environmental conditions by regulating their developmental processes to achieve high yields with improved quality characteristics.

There is a lack of scientifically grounded research on the optimal plant density for asparagus beans. This highlights the need to investigate this issue further and establish a rational plant spacing for the crop. By optimising sowing density, favourable conditions will be created for the progression of all growth and development phases of *Vigna* plants, which will influence the formation of high fruit yields.

The aim was to study the growth and development characteristics of *Vigna* about standing density to optimise the productivity of the varieties.

## Materials and Methods

Field studies were conducted from 2014 to 2016 at the collection plots of the educational laboratory "Fruit and Vegetable Garden" at the National University of Life and Environmental Sciences of Ukraine. The soils in the research area are dark grey, medium podzolized, and light loamy, with a slightly acidic soil reaction. The humus horizon has a depth of 24-28 cm. The soil was characterised by a low humus content (1.5-2.2%), average levels of hydrolysed nitrogen (26-38 mg/kg), available phosphorus (43-61 mg/kg), and potassium (28-34 mg/kg). In the years studied, the sum of effective air temperatures (>10°C) during the growing period of the *Vigna* varieties averaged 938-1,114°C, while the total rainfall ranged from 125 to 136 mm.

The study was a two-factor design. The factors examined were: Factor A – the varieties of bush asparagus bean, Kafedralna (Ukraine) and U-Cha-Kontou (China) (control); Factor B – plant density of 143,000 plants/ha (70×10 cm); 57,000 plants/ha (control) (70×25 cm); 36,000 plants/ha (70×40 cm); and 29,000 plants/ha (70×50 cm). The control was established as the 70×25 cm scheme (57,000 plants/ha) with the Chinese variety U-Cha-Kontou, which was obtained from the National Centre for Plant Genetic Resources of Ukraine. Preliminary data indicated that this particular variety stood out among all the original materials of bush-type *Vigna* (Bobos *et al.*, 2023a).

Additionally, an important aspect was establishing the relationship between growth conditions and yield indicators, which allowed for the identification of optimal agronomic parameters for cultivating *Vigna* in the temperate climate of Ukraine. The influence of meteorological conditions on plant development was considered, particularly temperature regimes and precipitation levels, both of which had a significant impact on yield formation. Phenological observations included recording the dates of germination, flowering, and pod maturation, enabling an assessment of the varieties' adaptive capabilities to specific climatic conditions. A separate analysis of pests that most actively affected yield reduction was conducted, leading to the development of recommendations for a pest and disease management system for *Vigna* crops.

The study consisted of three replicates. The total area for observation was 75 $m^2$, with an individual plot size of 5 $m^2$. Data were collected from 30 plants, with 10 plants from each replicate (Bondarenko & Yakovenko, 2001). Seeds of the varieties were sown on 27 April 2014, 27 April 2015, and 27 April 2016 simultaneously. Care for the plants included regular tillage, weed control, and protection against diseases and pests. The experiments involved phenological observations, biometric measurements of the plants, yield assessments, biochemical analyses, and entomological and phytopathological inspections for damage to the crops caused by pests and plant diseases (Bobos *et al.*, 2023b). Harvesting of beans at technical maturity was carried out weekly on all experimental variants. Harvesting of beans at biological maturity was conducted between 20 and 29 September, during which the number, weight, length of pods, and the number of seeds per pod were recorded.

To determine the impact of sowing density on yield, a comparative analysis was conducted using statistical methods, which included the calculation of mean values, variance analysis, and hypothesis testing. Special attention was given to the study of biochemical indicators, such as the protein and carbohydrate content in the seeds, which are important criteria for assessing crop quality. Analysis of variance (ANOVA) was performed using MS Excel with the XLSTAT add-in. Significant differences were considered valid at $\alpha = 0.95$ (Rao, 2018). During the research, adherence to the Convention on Biological Diversity (1992) and the Convention on the Trade in Endangered Species of Wild Fauna and Flora (1973) was ensured.

## Results and Discussion

During the research, it was established that in the initial phases, the growth and development of the plants occurred simultaneously, regardless of density. The difference in the timing of phenological phases was 1-3 days, which fell within the experimental error margin. A critical factor for obtaining high yields of vegetable crops, including the asparagus bean, is the emergence of uniform seedlings. The field germination of plants was not influenced by plant density in the studied varieties and averaged around 84% (Fig. 1).

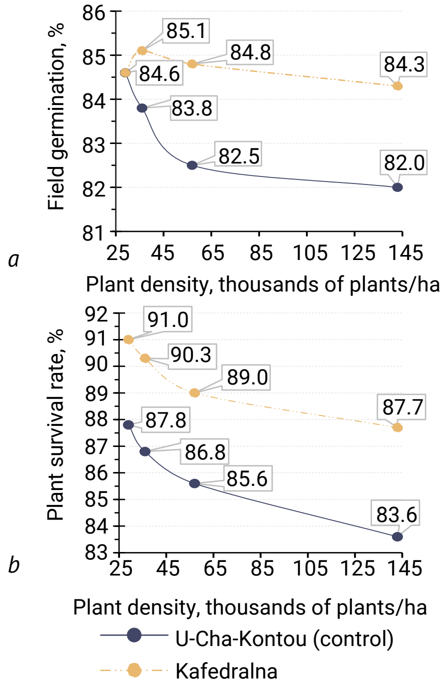


***Figure 1.*** *The impact of plant density on field germination (a) and plant survival rate (b) of cowpeas (average for 2014-2016)*

**Source:** compiled by the authors

A decrease in field germination for the varieties Kafedralna and U-Cha-Kontou was noted with an increase in sowing rate. Observations of the crops during the growing season revealed that optimal conditions for the growth and development of asparagus beans were found in sparsely sown areas with a plant density of 29,000 plants per hectare. This indicates favourable conditions for the formation of robust plants. At the same time, the percentage of plant survival in the varieties varied depending on plant density. The extremes of the survival rate in U-Cha-Kontou ranged from 83.6% to 87.8%, with a variation range of 4.2%, while for Kafedralna, it ranged from 91.0% to 87.7% (with a variation range of 3.3%). The lower variation in the survival rate of the Kafedralna variety suggests its superior adaptive traits to specific growing conditions. Variability in plant survival during the growing season increased in denser sown areas. Consequently, plants from the varieties at a density of 143,000 plants per hectare exhibited lower survival rates, with U-Cha-Kontou at 83.6% and Kafedralna at 87.7%.

The research established that plant density influenced the precocity of the crop varieties. When seeds were sown on 30 April, the growing period of the varieties was reduced by six days in denser plantings (143,000 plants/ha) compared to sparse plantings (29,000 plants/ha). A characteristic feature of the asparagus beans is the formation of flowers with long, cream-coloured peduncles (Fig. 2). Flowering depends on plant density. Later flowering was observed in varieties grown in sparsely sown areas with plant densities of 29,000-36,000 plants/ha, occurring between 24-27 June. At the same time, increased planting density accelerated the earliness of the varieties. For example, with higher plant densities, the phases of flowering onset and pod ripening occurred 2-3 days earlier compared to the control. The biological maturity of the beans was influenced by plant density. The onset of biological maturity in the beans was observed earlier in thinned stands. At plant densities of 29,000 and 36,000 plants/ha, the biological maturity of U-Cha-Kontou and Kafedralna varieties began on 27 August and 22 August, respectively, which was 2-5 days later than the control. The prolonged flowering and fruiting periods allowed for multiple harvests throughout the growing season. The duration of the interphase periods varied between cultivars and depended on plant density (Fig. 3). The duration of the period from germination to the beginning of flowering was 46-51 days for both varieties, regardless of plant density. The Kafedralna variety was more precocious in all plant spacing treatments. However, at the lowest plant density (29,000 plants/ha), the duration of this period was shortest, at 44 days, which was 11 days less compared to the U-Cha-Kontou variety.

***Figure 2.** Fruit formation of the Kafedralna variety*

**Source:** authors' photo

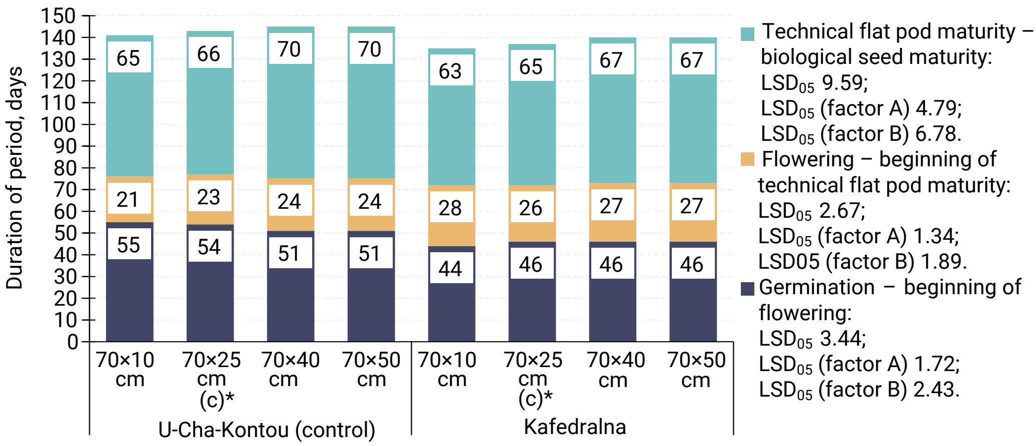


***Figure 3.** Influence of plant density on the duration of phenological phases in bush Vigna varieties, days (average for 2014-2016)*

**Note:** (c)* – control

**Source:** compiled by the authors

Different plant densities within the crop stand create varied growing conditions, influencing the duration of the growing period. The period from mass germination to the beginning of technical maturity decreased with increasing plant density. This trend was consistent for both the U-Cha-Kontou and Kafedralna varieties, with a growing period lasting 72-76 days. The period from full germination to the onset of technical flat pod maturity was longer in varieties grown at lower densities (29-36 thousand plants/ha), 78 days for U-Cha-Kontou and 73 days for Kafedralna. Increasing plant density shortened the duration from flowering to technical flat pod maturity, a trend linked to high temperatures in July-August, which accelerated the progression of all growth and development phases.

The period from full germination to the onset of biological maturity was influenced by plant density, with a shorter duration observed under the planting scheme of 70×10 cm and a density of 143,000 plants/ha for the Kafedralna variety (135 days). This was attributed to the higher plant density accelerating the onset of all growth and development phases of asparagus bean plants due to the faster warming of the soil surface. Additionally, the Kafedralna variety demonstrated to be more precocious, with all phenological phases progressing more quickly.

The maturation of beans on the plant occurs unevenly, necessitating multiple harvests of the flat pods. A lower plant density of 29-36,000 plants/ha contributed to an extended fruiting period for the beans. Additionally, a longer period from emergence to the biological maturity of the beans was observed in the more sparsely planted U-Cha-Kontou variety, which took 145 days, 4 days longer than the control.

Increased planting density also influenced the length of the growing season for the asparagus bean varieties, reducing it to 135-141 days, which is 2-3 days shorter than the control variant. In contrast, the growing season for the more sparsely planted varieties extended to 140-145 days. At a plant density of 29-36,000 plants/ha, both the technical and biological maturity stages occurred simultaneously in the varieties. For example, these stages for the U-Cha-Kontou variety were 78 and 145 days, respectively, while for the Kafedralna variety, they were 73 and 140 days.

The duration of the interphase periods in asparagus bean varieties was influenced by plant density. The growing conditions in the fields with varying plant densities affected the length of the growing season for the varieties. Increased plant density resulted in a shorter period from germination to technical maturity. A similar pattern was observed in the progression of all growth and development phases in the asparagus bean varieties. The U-Cha-Kontou and Kafedralna varieties exhibited more precociously in denser plantings (143,000 plants/ha), with a shorter growing season of 135-141 days.

The stem length of the U-Cha-Kontou variety varied between 26.5 and 32.9 cm, depending on the planting scheme (Table 1). The greatest stem length was observed with the planting scheme of 70×10 cm at a density of 143,000 plants/ha, while the shortest stem length was recorded with the 70×50 cm scheme at a density of 29,000 plants/ha. On average, over the study years, the Kafedralna variety had a shorter stem length compared to U-Cha-Kontou, ranging from 25.6 to 31.7 cm. The Kafedralna variety also exhibited a clear trend of increased stem length with higher plant densities.

***Table 1.** Characteristics of morphological traits of cowpeas under different planting schemes (average for 2014-2016)*

| Experimental variants (factor B) | Plant density, thousand plants/ha | Stem length, cm | Number of shoots, pcs | Pod length, cm |
|---|---|---|---|---|
| U-Cha-Kontou (control)(factor A) | | | | |
| 70 × 10 | 143 | 32.9 | 4.3 | 26.2 |

***Table 1.*** *Continued*

| Experimental variants (factor B) | Plant density, thousand plants/ha | Stem length, cm | Number of shoots, pcs | Pod length, cm |
|---|---|---|---|---|
| U-Cha-Kontou (control)(factor A) | | | | |
| 70 × 25 (control) | 57 | 32.2 | 5.4 | 24.2 |
| 70 × 40 | 36 | 27.5 | 6.5 | 23.4 |
| 70 × 50 | 29 | 26.5 | 6.8 | 22.7 |
| Kafedralna | | | | |
| 70 × 10 | 143 | 31.7 | 4.6 | 26.5 |
| 70 × 25 (control) | 57 | 30.3 | 6.1 | 24.8 |
| 70 × 40 | 36 | 27.4 | 7.5 | 24.3 |
| 70 × 50 | 29 | 25.6 | 7.9 | 23.4 |
| $LSD_{05}$ | | 1.04 | 0.18 | 0.85 |
| *factor A* | | 0.52 | 0.09 | 0.43 |
| *factor B* | | 0.74 | 0.12 | 0.60 |

**Source:** compiled by the authors

Sparser planting promoted the formation of more shoots on the cowpea plants. For instance, under the planting scheme of 70 × 50 cm with a density of 29,000 plants/ha, the number of shoots was the highest: 6.8 for the U-Cha-Kontou variety and 7.9 for the Kafedralna variety. Similar to stem length, pod length showed a direct correlation with plant density. As the plant density increased from 29,000 to 143,000 plants/ha, pod length increased from 23.4 to 26.5 cm for the Kafedralna variety and from 22.7 to 26.2 cm for the U-Cha-Kontou variety.

Plant density is regulated to achieve maximum yield, as plants compete with one another after germination (Bastos *et al*., 2020). For the growth and development of leguminous crops such as *Vigna*, seeding density plays a crucial role. According to S.D. Oliveira *et al*. (2015), a larger population of plants results in lower siliquae productivity per plant. This phenomenon can be attributed to high inter- and intra-plant competition at elevated population densities, which leads to flower abortion and a reduction in the number of lateral branches. These findings are consistent with the research conducted by E. François *et al*. (2017), who assert that a spacing of 40 × 40 cm between plants enhances light accessibility, thereby improving photosynthetic processes. Conversely, at higher plant densities, the duration of the growing season is reduced, with leaves predominantly forming lower on the plant, resulting in decreased yield.

The current study established that the duration of interphase periods in asparagus bean varieties was dependent on plant density. An increase in plant density affected the reduction in the duration of the period from germination to the onset of technical maturity. These results corroborate the findings of N.S. Tehulie *et al*. (2021). At the same time, research by T. Nleya *et al*. (2020) conducted on soybeans indicates that a high seeding rate delays flowering and decreases the number of shoots per plant. R.F. Chen *et al*. (2015) determined that the number of seeds sown in a single planting hole directly influences the stand density of plants. This factor is critical for the formation of the optimal feeding area for each plant, which, in turn, affects their development, productivity, and resilience to stress conditions. Excessively dense planting can lead to competition for resources such as light, water, and nutrients, adversely impacting yield.

On the other hand, insufficient density may lead to ineffective resource utilisation and a reduction in overall field productivity. Plant density is regulated not only by the sowing scheme but also by the number of seeds sown per planting hole. N.G. Yalombe *et al.* (2018) assert that sowing one seed per planting hole promotes optimal plant growth and development, thereby increasing yield. Similar claims have been reported by Y.J. Gnamien *et al.* (2023). The lowest plant density of 62,500 plants per hectare (40 cm x 40 cm) with one plant per planting hole resulted in a higher yield compared to the treatment of 250,000 plants per hectare (20 cm × 20 cm) with two plants per planting hole. At the same time, these findings contradict the results of U.S. Yannick *et al.* (2014). The authors state that *Vigna* yield is higher when three seeds are sown per planting hole, which can be attributed to the differing spacing between plants.

Extreme temperatures also influence the growth rates of plants throughout their life cycle. Research conducted by J.L. Hatfield & J.H. Prueger (2015) and D. Schmidt *et al.* (2017) indicates that the reproductive development stage is the most sensitive to extreme temperatures across all plant species. In different regions, sowing density may vary. F.O. Oroka (2017) demonstrated that for *Vigna* varieties with differing morphological structures, it is essential to select varying plant densities to ensure a high yield of pods at technical maturity. Sowing density affects not only yield but also the precocity of varieties, as confirmed by observations in this study. The varieties U-Cha-Kontou and Kafedralna exhibited more precocious in densely sown fields (143,000 plants per hectare) with a shorter growing period of 135-141 days.

D.A. Animasaun *et al.* (2015) and O.A. Osipitan (2017) asserted that the introduction of varieties from other countries and their evaluation for the selection of superior strains is a crucial step in breeding new, desirable plant varieties. Variations among parental genotypes and crossings reflect genetic diversity and the potential for selection. According to the findings of H.E. Zaki & K.S. Radwan (2022), crosses involving the genotypes “Al” and “Com1” enhanced the performance of other varieties, namely “Col”, “D331”, and “Cr7”. The crossings Cr7 x Com1 and D331 x Al were identified as the most promising breeding programmes focused on *Vigna*.

The results of the study indicated that the biological characteristics of the variety, alongside ecological and agronomic factors, influence the dynamics of formation and the intensity of all assimilatory processes in the plant. These factors determine the rate of growth and development, the intensity of photosynthesis, and ultimately the yield. The duration of phenological phases in the growth and development of asparagus bean plants was found to depend on planting density. Increased plant density affected the reduction in the duration from the onset of mass germination to technical maturity throughout the entire growing period of the studied asparagus bean varieties. The shortest plant height and pod length for the cowpeas occurred at a density of 29,000 plants per hectare, while these measurements increased with higher densities. Sparse planting positively influenced the number of shoots produced by the plants.

## Conclusions

The planting schemes influenced the precocity of the species. Nevertheless, the varieties of cowpea were characterised as precocious regardless of the planting scheme, which is attributed to the bushy growth form of the stems in these varieties. However, when sowing seeds on 30 April, the growing period for asparagus bean varieties was reduced by six days in dense plantings (143,000 plants per hectare) compared to the lowest plant density (29,000 plants per hectare). The duration of the period from germination to the onset of flowering in the varieties ranged from 46 to 51 days, regardless of plant density. The Kafedralna variety was the most precocious across all planting configurations, with the shortest duration of 44 days observed at the lower plant density (29,000 plants per hectare).

An increase in plant density was associated with a reduction in the duration of the period from the onset of mass germination to technical maturity. This trend was evident for both the U-Cha-Kontou and Kafedralna varieties, which exhibited a growing period of 72 to 76 days. In contrast, the period from full germination to the onset of technical maturity for the varieties was longer under sparse plantings (29,000 to 36,000 plants per hectare), with durations of 78 days for U-Cha-Kontou and 73 days for Kafedralna. Furthermore, an increase in plant density shortened the duration from flowering to the attainment of technical maturity. The U-Cha-Kontou and Kafedralna varieties were more precocious in dense plantings (143,000 plants per hectare), exhibiting a shorter growing period of 135 to 141 days. This pattern is linked to the high temperatures experienced in July and August, which accelerated the progression of all phases of plant growth and development. The Kafedralna variety has proven to be adaptive to growing conditions characterised by a short duration of phenological phases of growth and development. It can be utilised by producers for the harvest of flat pods and in breeding programmes aimed at developing precocious varieties of asparagus beans. However, the promotion of less common legumes in the market is hindered by consumer unfamiliarity with these crops. Therefore, a subsequent priority for research will be to establish mechanisms for their popularisation and subsequent integration into dietary practices.

## Acknowledgements

None.

## Conflict of Interest

None.

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## Ріст і розвиток сортів вігни спаржевої залежно від густоти рослин

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**Анотація.** Ріст, розвиток і продуктивність вігни овочевої залежать від ґрунтово-кліматичних умов та технології вирощування, зокрема, від оптимальної густоти стояння, яка потребує наукового обґрунтування в умовах Правобережного Лісостепу України. Мета досліджень полягала у вивченні особливостей росту та розвитку вігни в залежності від густоти стояння для оптимізації продуктивності сортів. Методи дослідження: польові – для вивчення елементів технології вирощування; статистичні – для оцінки достовірності отриманих результатів. У дослідженні, проведеному в 2014-2016 роках, вивчали вплив густоти стояння на два сорти вігни овочевої («У-тя-Контоу», «Кафедральна») за чотирма схемами вирощування (70×10 см, 70×25 см, 70×40 см, 70×50 см). З'ясувалося, що густота стояння значно впливає на ріст, розвиток, фенологію та продуктивність вігни. Польова схожість коливалась від 80,0 % до 85,1 % у мажах досліджуваних варіантів. Відмічено, що збільшення норми висіву зменшувало польову схожість насіння сортів. Серед сортів спостерігалися відмінності за відсотком збереження рослин протягом вегетаційного періоду. Екстремальні значення цього показника коливалися від 83,6 % до 87,8 % у сорту «У-Тя-Контоу», а у сорту «Кафедральна» – від 87,7 % до 91,0 %. За густоти стояння рослин 29-36 тис. рослин/га початок цвітіння у сортів спостерігався пізніше (24-27.06). Крім того, фази початку цвітіння й дозрівання плодів спостерігався раніше на 2-3 дні порівняно з контролем. Період від початку сходів до цвітіння тривав 46-51 днів. У сортів «У-тя-Контоу» та «Кафедральна» біологічна стиглість спостерігалася 27 та 22 серпня, відповідно, з густотою рослин 29-36 тис. рослин/га. Найбільш скоростиглими виявилися рослини у загущених посівах – 143 тис. шт./га, де тривалість вегетаційного періоду сортів становила 135-141 день. Результати досліджень можуть бути цінними для практичного використання овочівниками, селекціонерами, спеціалістами, що цікавляться питаннями вирощування, зберігання та переробки овочів

**Ключові слова:** схеми сівби; польова схожість; ступінь виживання рослин; фази росту та розвитку; технічна стиглість; боби