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Dmytro Kyselov*
PhD in Agricultural Sciences
Private Enterprise "Zakhidnyi Buh"
80250, 39 Yunosti Ave., Pavliv Village, Ukraine
https://orcid.org/0009-0005-6771-8337

Taras Bliatnyk
Senior Agronomist
Private Enterprise "Zakhidnyi Buh"
80250, 39 Yunosti Ave., Pavliv Village, Ukraine
https://orcid.org/0009-0001-1712-3117

Svitlana Kalenska
Doctor of Agricultural Sciences
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0002-3392-837X

Sowing parameters as a factor in emergence synchrony and productivity of sugar beet crops

Abstract. Modern sugar beet production is characterised by rising climate instability and the increasing impact of the early stages of organogenesis on crop productivity. In the conditions of a cool and wet spring, the problem of optimising the manageable sowing parameters, which can ensure the uniformity of seed germination and the synchrony of plant growth, acquires particular relevance. This study aimed to provide a scientific justification for the influence of coulter downforce and seeder travel speed on emergence synchrony and root mass formation in the sugar beet hybrid KWS 'Riorita' in the conditions of the Western Forest-Steppe of Ukraine. The research was carried out in 2025 on a productive research field on podzolised medium loam chernozem in the contrasting hydrothermal conditions of the sowing period. The experimental scheme included varying the coulter downforce and the seeder travel speed. The dynamics of seedling emergence, emergence synchrony, the spatial uniformity of the stand and root mass formation were measured. Statistical analysis was processed using analysis of variance and regression methods. It was found that an increase in coulter downforce to 40-60 kg significantly reduced the number of late-emerging seedlings and provided emergence synchrony at 96%, while with minimal pressure, it did not exceed 84%. A decrease in the proportion of seedlings emerging on days 9-10 after sowing was accompanied by an improvement in the uniformity of the stand and a stabilisation of the average root mass. A biological optimum was determined for the seeder travel speed at 7 km·h^{-1}, at which

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*Corresponding author (*dmytro.kyselov@zahbug.com.ua*)

the best combination of spatial uniformity of sowing, high emergence synchrony and maximum root mass was achieved. A decrease and excessive increase in speed negatively affected productivity. The quantitative analysis showed that a delay in emergence of 1 to 2 days led to a sharp decrease in root mass; the late-emerging plants formed roots with 24% to 39% lower mass compared to the early emerging ones. The practical significance of the study is to substantiate the sowing parameters aimed at minimising emergence asynchrony as a key prerequisite for the stable formation of sugar beet yield under production conditions

Keywords: coulter downforce; seeder speed; early plant development; root mass; sowing technology

INTRODUCTION

In the last few years, sugar beet cultivation has faced technological and agroecological problems concentrated in the phase of crop establishment. In the conditions of spring sowing, a significant variability in the temperature and humidity of the soil, as well as technological parameters of the sowing unit, is observed, which can cause significant differences in the uniformity and synchrony of the seedlings' emergence, which in turn determine the structure of the yield. The synchrony of the emergence is a critical element of the productive potential of sugar beet, since the first few days after the emergence of the seedlings determine the competitive advantages of the plants, fix the spatial distribution of the biomass and lay the foundation for the subsequent heterogeneity of the root formation. That is why the research on the influence of the controlled technological parameters of the sowing (mainly the downforce of the coulter and the operating speed of the sowing unit) is important for the scientific substantiation of technological solutions for the uniformity of the sowing and the stability of the yield, in the conditions of variable technologies of the modern sugar beet cultivation.

The sensitivity of the establishment phase of the sugar beet crop to the risk of weather factors was consistently studied by A. Tataridas *et al.* (2022), who, by modelling methods, showed that the combination of low temperatures and excessive humidity of the soil significantly increases the risk of asynchronous emergence and uneven density of plant stand. This indicates that technological parameters, which affect the microconditions of germination, have a disproportionately strong effect in these conditions. A similar conclusion, but in a broader agroclimatic aspect, was made by S. Bastaubayeva *et al.* (2022), who noted that the productivity of sugar beet is largely determined by weather conditions in the initial growth period, and the stabilisation of the initial development processes is one of the most effective ways to reduce the inter-annual variability of the yield. The deepening of the research into the issue of the emergence synchrony is connected with the research in the physics of the seedbed and the seed-soil contact. K. Tuğrul (2022) experimentally showed that at the same agrochemical conditions, the determining factor of the uniformity of germination is the quality of the mechanical seed-soil contact, which regulates the local water regime, the rate of soaking and initial gas exchange. In applied terms, this means that the factors influencing the downforce and the stability of the coulter operation can be decisive in ensuring the uniform emergence of the crop in the conditions of a cool spring. The biological aspect of the problem is confirmed by the results of the research of M. Kaya & E. Kulan (2020), who showed that sugar beet seeds in conditions of low-temperature stress are particularly sensitive to the prolonged phase of germination; in these conditions, any heterogeneity of the microenvironment of the sowing layer increases the dispersity of the timing of emergence. Therefore, the management of the sowing parameters should be considered not only as a "mechanical" control, but also as a means of physiological stabilisation of the initial development phases of the plants.

A separate group of contemporary studies indicates that non-uniform emergence manifests in the harvest yield and quality. R. Nowicki *et al.* (2025), analysing technological operation timing in sugar beet production, draw attention to the fact that the initial growth rate discrepancy remains in the yield structure until harvest, resulting in a shift in root fractions, and, as a consequence, in the economic efficiency of the production system. A similar line of research was carried out by H. Rimaz *et al.* (2020), who found that the change in sowing and harvesting time leads to changes in the stability of white sugar yield, and the initial development stage constitutes an essential part of the variance in productivity between treatments. This indicates that under modern intensive production conditions, the initial development stage remains a bottleneck that depends on technological accuracy. Generalisations at the system level on the sustainability of sugar beet production technologies are contained in the research of Z. Gazdík *et al.* (2025), who, in a review of the concept of sustainable production, emphasised the importance of field operation accuracy and the controllability of the processes determining crop uniformity. It is also important that modern technological solutions are evaluated not only for the final yield level but also for their ability to reduce the risk and losses due to heterogeneity of the crop. In this sense, D. Grunwald *et al.* (2025), considering integration within crop protection systems, effectively emphasise the need for integration of technological factors: even the strongest elements of the crop management systems realise their full potential more effectively against the background of a uniform and well-established crop stand. In this context, the authors' results on the role of agronomic factors in sugar beet production systems indicate that technological details of individual operations influence the efficiency of resource use in crop rotation rather than at the single-season level.

A practical scheme for interpreting controllable agronomic factors is given by S. Paul (2022), who systematised the key elements of sugar beet management and noted that optimising technological parameters is one of the most cost-effective ways to increase yield stability in production conditions. In this respect, the sowing parameters are of primary importance as they predetermine the initial conditions that cannot be fully compensated for by other agronomic measures. The reviewed body of contemporary research indicates that the problem of emergence synchrony is located at the intersection of seedbed physics, germination physiology, and technological controllability of the sowing process and therefore requires applied quantitative assessment directly in production-research field conditions.

This study aimed to establish quantitative relationships between coulter downforce and seeder travel speed and their effects on emergence synchrony and productivity indicators of sugar beet crops under the conditions of the Western Forest-Steppe of Ukraine. The novelty of the research is the quantitative evaluation of the synchrony of emergence as a comprehensive index of the agrotechnical quality of sowing conditions under conditions of current production technologies.

MATERIALS AND METHODS

The field experiments were carried out in 2025 on the production research field of the Shymkivtsi unit of PE "Zakhidnyi Buh" (Zolochiv District, Lviv Region; 49°97′ N, 25°15′ E). The soil of the experimental site was podzolised medium loam chernozem, with a humus content of 3.4%, soil solution reaction pH (KCl) 6.7, available phosphorus content of 58 mg $P_2O_5 \cdot kg^{-1}$ of soil, and potassium content of 112 mg $K_2O \cdot kg^{-1}$ of soil. The long-term average annual precipitation in the experimental zone was 640 mm, and the mean daily air temperature during the growing season (April-October) was 17.1°C. In the spring of 2025, the first decade of April was noted for its increased moisture (up to 28 mm of precipitation) and low soil temperatures during the sowing period (+8°C to +10°C), which contributed to the formation of contrasting agroecological conditions for germination and activation of the agrotechnical sensitivity of the crop to sowing parameters, first of all mechanical (Lamichhane *et al.*, 2019; Bastaubayeva *et al.*, 2022).

The object of the study was sugar beet (*Beta vulgaris* L.), hybrid KWS 'Riorita', which is widely used in commercial crops in the region and is characterised by a high productivity potential. Soil tillage was carried out according to a conventional combined system, which included primary tillage by Horsch Tiger AS unit

(Germany) to a depth of 30-32 cm, spring harrowing by Degelman StrawMaster unit (Canada) and pre-sowing cultivation by FARMET Kompaktomat unit (Czech Republic) to a depth of 2.5-3.5 cm. The pre-sowing moisture content of the arable layer was 22.8%, the bulk density was 1.25 g·cm^{-3}, and the temperature of the soil at a depth of 5 cm was 10.2°C.

Sugar beet was sown on 17 April 2025 by Kverneland Monopil 24SE seeder (Norway) with a row spacing of 45 cm and a seeding rate of 120 thousand seeds per ha^{-1}. Within the framework of the experiment, two technological factors were changed: factor A is coulter downforce: 20 kg (minimum pressure), 40 kg (moderate, conventionally optimal pressure), and 60 kg (increased pressure); factor B is seeder travel speed: 4 km·h^{-1}, 7 km·h^{-1}, and 10 km·h^{-1}. Counting of seedlings was carried out on days 6, 7, 8, 9, and 10 after sowing. Field germination (%) was calculated by formula (1):

$$P = \frac{N_f}{N_s}, \tag{1}$$

where *Nf* is the number of emerged seedlings within the sampling area, *Ns* is the number of sown seeds.

After row closure (BBCH 16-18), the number of plants was counted in four rows, each with a length of 22.2 m. The uniformity of the plant stand was evaluated by the coefficient of variation (CV, %) of the distance between plants, which is a commonly used indicator of sowing quality (Varga *et al*., 2021). Yield evaluation was carried out on a sampling area of 10 m², from which all roots were dug out, after which the average root weight, the number of marketable and non-marketable roots, as well as the proportion of small (< 300 g) and large (> 1.2 kg) roots were determined. Sugar content, dry matter and technological impurities were determined in the root composite samples by the ICUMSA polarimetric method, which has been widely used in the international sugar beet research. P. Stevanato *et al*. (2019) stressed the importance of using a standardised polarimetric method to ensure the comparability of data among different research institutions.

Air and soil temperature and precipitation were measured using the automatic Davis Vantage Pro2 weather station (USA) installed on the experimental field. Data processing was carried out using Statistica 13.3 and Microsoft Excel 365 software packages. The data were analysed by analysis of variance (ANOVA), followed by Duncan's test at a significance level of $p < 0.05$. The relationships between the emergence synchrony, the uniformity of plant distribution and the root mass were estimated using the Pearson correlation and multiple regression analysis, where the explanatory variables included coulter downforce, sowing unit travel speed, soil temperature and soil moisture (Anar *et al*., 2019; Varga *et al*., 2021).

The field experiments were carried out in compliance with the ethical standards of the Convention on Biological Diversity (1992) and the Convention on the Trade in Endangered Species of Wild Fauna and Flora (1973). The study did not involve the use of genetically modified organisms, it did not imply interference into the natural ecosystems beyond the experimental plot, it did not create a risk for human or animal health, it did not include human subjects as the object of study, it did not involve any biomedical or socio-humanitarian manipulations and, therefore, it did not require a permission from the bioethics commission. Although the research was funded by the enterprise at whose facilities it was carried out, its results were independent, objective and served no private interests.

RESULTS AND DISCUSSION

The data of the 2025 field experiments showed that the coulter downforce and the sowing unit travel speed were the determining technological factors of the emergence synchrony of the sugar beet hybrid KWS 'Riorita' and, therefore, of the uniformity of the productivity elements. In the conditions of the cool and moist weather during the sowing period (soil temperature +8°C to +10°C), the mechanically caused differences in the seedbed structure and the seed-soil contact were manifested mainly through the changes in the proportion of late-emerged seedlings. These results agree with the data of S. Bastaubayeva *et al*. (2022), who found that the fluctuations in the soil temperature within the range of 5-10°C prolonged the seed imbibition period and increased the variation in the emergence terms. The high sensitivity of the sugar beet seeds to the low temperatures was also noted by M. Kaya & E. Kulan (2020). R. Esmaeili *et al.* (2022) pointed out the decisive importance of the uniform seed-soil contact for synchronous germination. Similar response of crop establishment processes to seedbed physical parameters was reported by S. Blunk *et al.* (2018), who emphasised the role of microsite stability for germination and J. Lamichhane *et al.* (2019), who pointed out that a higher risk of asynchronous emergence can occur under fluctuating temperature and moisture conditions in early spring. The change in coulter downforce within the studied range (20-60 kg) caused significant differences in emergence synchrony and in the distribution of emergence timing. The highest proportion of seedlings emerged in the optimal period (6-8 days) was found at an increased downforce (60 kg), while at the minimum pressure (20 kg), a higher proportion of late-emerged seedlings (9-10 days) was observed, which is undesirable for the formation of a uniform crop structure. In addition, M. Licht & M. Al-Kaisi (2005) found that even a small delay in emergence leads to permanent biomass differentiation during the growing season.

The differences in the average root mass between the downforce levels were less pronounced; however, the direction of influence generally repeated the pattern: the reduction in the proportion of lateemerged plants was accompanied by greater stability in root mass formation. Thus, the influence of coulter downforce was realised indirectly, through the regulation of the emergence timing distribution rather than through direct stimulation of growth processes. The main quantitative indices of the influence of coulter downforce on emergence synchrony and average root mass are given in Table 1.

Table 1. Effect of coulter downforce on emergence synchrony and average root mass (observations on 04 August 2025)

Coulter downforce, kg	Emergence on days 6-8, %	Emergence on days 9-10, %	Average root mass, g
20	84.0 ± 2.1 b	16.0 ± 1.8 a	526 ± 18 b
40	85.0 ± 1.9 b	15.0 ± 1.5 a	552 ± 17 a
60	96.0 ± 1.2 a	4.0 ± 0.9 b	545 ± 16 a

Note: letters within a column indicate significant differences according to Duncan's test ($p < 0.05$)
Source: original research data

The ANOVA results showed that the effect of the "coulter downforce" factor was significant ($p < 0.01$) for the proportion of seedlings emerged in the periods of 6-8 and 9-10 days, and ($p < 0.05$) for the average root mass. This indicates a cause-and-effect relationship between seedbed parameters and the distribution of emergence timing. According to H.-J. Koch *et al.* (2018), emergence synchrony determines the level of intraspecific crop stand uniformity and is a premise for the further realisation of the yield potential, as an asynchronous start results in sustained morphological plant-to-plant differentiation. The analysis of the effect of seeder travel speed revealed the biological optimum at which the combination of technical evenness of plant spacing and physiological evenness of emergence provides the most favourable conditions for root mass formation. At a speed of 7 km·h^{-1}, moderate values of the coefficient of variation (CV) of interplant spacing coincided with a high proportion of seedlings emerging on days 6-8 and the maximum average root mass. A reduction in speed to 4 km·h^{-1} was associated with increased CV and reduced biological efficiency of the sowing. An increase in speed up to 10 km·h^{-1}, despite the reduction in CV and the increase in the proportion of early-emerged seedlings, was accompanied by a decrease in the average root mass.

The obtained results are in agreement with the data of R. Afshar *et al.* (2019), who found that the influence of tillage technologies and seedbed formation conditions on the emergence rate depends on the actual weather conditions. D. Górski *et al.* (2022) pointed out that water retention is usually associated with an increase in the heterogeneity of seedbed structure, while N. Mioduszewska *et al.* (2018) reported that an increase in the scatter of seed placement depth contributes to the asynchrony of emergence. A similar difference between geometric uniformity and biological effect is explained by S. Blunk *et al.* (2018), who showed that the disturbance of the stability of seed-soil contact at high operating speed of the seeder leads to latent stress of seedlings, which is not reflected in the indicators of spatial variability, but has a negative effect on further growth. The quantitative parameters of the effect of seeder operating speed on sowing uniformity, emergence synchrony and root mass are given in Table 2.

Table 2. Effect of seeder operating speed on sowing uniformity, emergence synchrony and root mass (observations on 04 August 2025)

Speed, $km \cdot h^{-1}$	CV of interplant spacing, %	Emergence on days 6-8, %	Average root mass, g
4	12.0 ± 0.8 a	80.0 ± 2.4 c	387 ± 21 b
7	10.0 ± 0.6 b	89.0 ± 1.7 b	464 ± 19 a
10	9.0 ± 0.5 c	94.0 ± 1.4 a	358 ± 23 b

Note: letters within a column indicate significant differences according to Duncan's test ($p < 0.05$)
Source: original research data

It was found by ANOVA that the effect of the "seeder operating speed" factor was significant ($p < 0.01$) for the coefficient of variation of the distance between plants, the share of seedlings emerged during days 6-8 and average root mass, which testifies to the direct influence of the kinematic parameters of the seeder operation on the biological effect of the sowing process. The biological sensitivity of the germination process to the physical properties of the seedbed, in particular to the stability of seed-soil contact and to the micro-irregularities of compaction, is in agreement with the results of S. Blunk *et al.* (2018), who found that even minor violations of the seedbed structure lead to asynchronous emergence. The main result of this research is the quantitative substantiation of the fact that the timing of seedling emergence determines the subsequent differentiation of plant productivity, while technological factors influence indirectly through the regulation of the share of late-emerged seedlings. A consistent decrease in the average root mass with a shift of seedling emergence to later dates was observed, which indicates the formation of a stable hierarchical structure of the crop stand. This dependence corresponds to the concept of the "priority effect", which consists of the fact that earlyemerged plants receive a competitive advantage in terms of light, nutrients and root space at the initial stages of organogenesis.

Similar dependences were obtained by I. Varga *et al.* (2021), who found a decrease in both the proportion of commercial roots and the sucrose content in plants that emerged later. R. Esmaeili *et al.* (2022) also pointed out the long-term differentiation of biomass due to asynchronous initial development. In the growth models of M. Anar *et al.* (2019), the day of emergence appeared as one of the most sensitive parameters for predicting yield. Similar conclusions were drawn by H.J. Koch *et al.* (2018), who showed the limited compensatory potential of late-emerging plants even under favourable agrotechnical conditions. D. Grunwald *et al.* (2025) also pointed out that the hierarchy formed in the early stages remains until harvest and is responsible for the variation in root mass. Consequently, sowing conditions should be viewed not only as a means of controlling the technical uniformity of seed placement but also as a biological synchroniser of plant development, which is a necessary condition for creating a uniform and productive sugar beet crop.

A quantitative study of the relationship between root mass and day of emergence revealed a clearly defined gradient (Table 3). The highest average root mass was formed by plants that emerged on the 6th day after sowing, and with each subsequent delay in emergence, this indicator statistically significantly decreased. According to the ANOVA, the effect of the "day of emergence" factor on root mass was highly significant ($p < 0.001$), which indicates the determining role of temporal synchrony at the early stages of development in the formation of productivity.

Table 3. Dependence of root mass on the day of emergence (observations on 04 August 2025)

Day of emergence	Average root mass, g	Deviation from maximum, %
6	573 ± 19 a	0
7	541 ± 18 a	-6
8	506 ± 17 b	-12
9	436 ± 21 c	-24
10	352 ± 24 d	-39

Note: letters within a column indicate significant differences according to Duncan's test ($p < 0.05$)
Source: original research data

As can be seen from Table 3, a one-day delay in germination reduced the average root mass by 6%, two days by 12%, while the potential losses from seedlings that emerged on the 9th-10th days reached 24-39% of the maximum. Different letter indices in the columns indicate significant differences between most variants according to the Duncan test ($p < 0.05$). The graphic representation of this dependence is presented in Figure 1, where a practically linear decrease in root mass with a delay in emergence is observed.

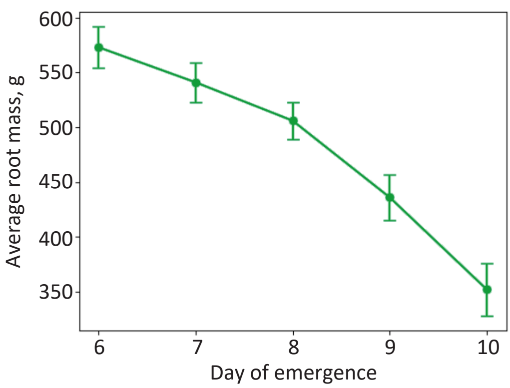

Figure 1. Dependence of average root mass on the day of sugar beet emergence (observations on 04 August 2025)
Source: original research data

The biological interpretation of this regularity is in line with the research of C. Chomontowski *et al.* (2020), M. Mirzaei & S. Hemayati (2022), and R. Nowicki *et al.* (2025), which emphasise the irreversibility of the early developmental superiority of seedlings in relation to root mass. A similar position is expressed by W. Samociuk *et al.* (2025), who note that even against the background of a uniform agrotechnical complex, late-emerging plants remain functionally dependent in the structure of the crop. Therefore, the synchrony of early emergence is an essential factor in the formation of the morphofunctional uniformity of the crop stand. The obtained data allow a practically significant conclusion to be drawn: control of the technological parameters of sowing should be directed, first of all, not at minimising the values of the indicators of geometric uniformity, but at minimising the share of late sprouts. Increasing the coulter downforce to the value ensuring the stability of the seed-soil contact and choosing the speed of the seeder, which does not worsen the biological indicators of the quality of sowing, are the necessary conditions for the creation of a uniform productivity structure. This conclusion is consistent with the modern paradigm of sustainable production of sugar beet, according to which the early development stage is considered a critical control point for the formation of the yield and the efficiency of its production, as was pointed out by P. Stevanato *et al.* (2019) and S. Paul (2022).

However, according to the results of J. Lamichhane *et al.* (2019), climate change will increase the risks of asynchrony of emergence, which will further increase the importance of technological stabilisation of the seedling emergence in the future sugar beet production systems. In general, it can be concluded that the synchrony of seedling emergence is an integrated indicator of the quality of sowing, which unites the mechanical, physical, and biological components of the creation of the productivity structure and is the main channel through which the influence of the studied technological parameters is realised.

CONCLUSIONS

The results of this study have confirmed the determining role of the sowing parameters in the formation of the seedling emergence synchrony and productivity of sugar beet (*Beta vulgaris* L.) crops of the KWS 'Riorita' hybrid under the conditions of the Western Forest-Steppe of Ukraine. It has been established that the coulter downforce and the speed of the seeder are the key manageable technological elements that control the uniformity of the early plant development and, as a consequence, have a significant effect on the root mass formation. Under the cool and wet weather conditions of the spring of 2025, the reduction of the asynchrony of the seedling emergence has proved to be especially important, as the late-emerged seedlings were not able to compensate for the delay in their growth and development during the growing season. An increase in the coulter downforce up to 40-60 kg has significantly reduced the proportion of the late-emerged seedlings and contributed to the creation of a more uniform stand structure. An increase in the seedling emergence synchrony from 84% to 96% has been accompanied by the stabilisation of the average root mass and a reduction in the in-stand variability. It has been demonstrated that the effect of the coulter downforce is realised not through the direct stimulation of the growth processes, but through the improvement of the physical conditions of the seed germination and the alignment of the rates of the early organogenesis.

A biological optimum of seeder travel speed was found: at 7 km·h^{-1}, the best spatial uniformity of seed placement, emergence synchrony and highest average root mass were combined. Both decreasing (4 km·h^{-1}) and increasing (10 km·h^{-1}) the seeder travel speed resulted in a productivity decline. This implies the impossibility of determining sowing quality based on geometric criteria only without accounting for the biological reaction of the crop. It is concluded that a delay in the emergence of even one or two days results in a loss in potential root mass of 24-39% for late-emerging seedlings. Therefore, the optimisation of the sowing regime should be aimed at ensuring maximum emergence synchrony as the main prerequisite for the formation of a uniform crop structure and stable realisation of the productive potential of sugar beet. Further studies should be aimed at the multi-year and multi-local verification of the revealed patterns, taking into account contrasting soil and climatic conditions, different genotypes of sugar beet, and a varied agrotechnical background. Of particular interest is the study of the interaction of coulter downforce and seeder travel speed with the physical properties of the seedbed (density, moisture, aggregate structure), and the integration of field experiments with modelling of the emergence process and yield formation. The application of digital monitoring systems for crop establishment, precise definition of the temporal dynamics of emergence and spatial analysis of the hierarchisation of plants within the stand seems promising. This will allow the development of adaptive recommendations for the calibration of the seeder for different soil types and weather conditions, which will increase the stability of sugar beet productivity in the context of increasing climate change.

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CONFLICT OF INTEREST

None.

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Дмитро Кисельов
Кандидат сільськогосподарських наук
ПП «Західний Буг»
80250, просп. Юності, 39, с. Павлів, Україна
https://orcid.org/0009-0005-6771-8337
Тарас Блятник
Старший агроном
ПП «Західний Буг»
80250, просп. Юності, 39, с. Павлів, Україна
https://orcid.org/0009-0001-1712-3117
Світлана Каленська
Доктор сільськогосподарських наук
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0002-3392-837X

Параметри сівби як фактор синхронності сходів і продуктивності посівів цукрових буряків

Анотація. Сучасні умови вирощування цукрових буряків характеризуються підвищеною кліматичною мінливістю та зростанням ролі стартових етапів органогенезу у формуванні продуктивності культури. За прохолодних і зволожених умов весняного періоду особливої актуальності набуває оптимізація керованих параметрів сівби, здатних забезпечити вирівняне проростання насіння та синхронний розвиток рослин. Метою дослідження було наукове обґрунтування впливу притискного зусилля сошників і швидкості руху сівалки на синхронність сходів і формування маси коренеплоду цукрових буряків гібриду КВС 'Ріоріта' в умовах Західного Лісостепу України. Дослідження проводили у 2025 році на виробничо-дослідному полі на чорноземі опідзоленому середньосуглинковому за контрастних гідротермічних умов посівного періоду. Схема досліду передбачала варіювання притискного зусилля сошників та швидкості руху сівалки. Обліки включали динаміку появи сходів, визначення синхронності сходів, оцінку просторової рівномірності посіву та формування маси коренеплоду. Статистичну обробку результатів здійснювали з використанням дисперсійного аналізу та регресійних методів. Установлено, що підвищення притискного зусилля сошників до 40-60 кг істотно зменшувало частку пізніх сходів і підвищувало синхронність сходів до 96 %, тоді як за мінімального тиску вона не перевищувала 84 %. Зменшення частки сходів, що з'являлися на 9-10-ту добу після посіву, супроводжувалося вирівнюванням агроценозу та стабілізацією середньої маси коренеплоду. Виявлено біологічний оптимум швидкості руху сівалки на рівні 7 км·год$^{-1}$, за якої забезпечувалося найкраще поєднання просторової рівномірності посіву, високої синхронності сходів і максимальної маси коренеплоду. Як зниження, так і надмірне підвищення швидкості негативно впливали на продуктивність. Кількісно доведено, що затримка появи сходів на одну-дві доби призводила до істотного зменшення маси коренеплоду, а пізні сходи формували коренеплоди на 24-39 % меншої маси порівняно з ранніми. Практична цінність роботи полягає в обґрунтуванні параметрів сівби, спрямованих на мінімізацію асинхронності сходів як ключової передумови стабільного формування врожаю цукрових буряків у виробничих умовах

Ключові слова: притискне зусилля сошників; швидкість сівалки; стартовий розвиток рослин; маса коренеплоду; технологія сівби