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RESEARCH OF INDEXES OF PLACEMENT OF SEEDLINGS OF SUGAR BEET FOR SOWING SEEDS BY MECHANICAL AND PNEUMATIC SEEDERS

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Abstract. The density of standing and uniform distribution of plants along the length of the linear the main factors of increasing the yield and sugar content in sugar beets. This has been proved since the 70s of the last century by the researches of domestic scientists of the Institute of Bioenergy Crops and Sugar Beet (Kyiv) and the All-Russian Research Institute of Sugar Beet and Sugar (Ramon, Voronezh region) and western European scientists.

The prerequisite for the uniformity of the stacking of beets is the uniformity of the intervals between the sown seeds, which is mainly provided by two factors. They are the perfection of the sowing machine and the field similarity of the seed, as close as possible to the laboratory condition.

In the 90's, sugar beet seed sown in Ukraine mainly by seeding machines of the mechanical type ССТ-12А and modernized ССТ-12Б and ССТ-12В of the designed by UkrNDISGOM (Kharkiv), Kirovogradsky PKI and Institute of Bioenergy Crops and Sugar Beet, and production of OJSC "Chervona zirka" (Kropivnitsky).

The SST-12V seed drill performs the granular fertilizers application simultaneously with sowing. In the complex with the feeder POM-630-1 it performs the introduction of a strip of liquid complex fertilizers or insecticides into the zone of lines. The use of the 18-row seeder ССТ-18В in comparison with the 12-line ССТ-12В allows shortening the seeding time. Due to these advantages, the 18-row and 24-row drills were developed in the Kirovohrad PCI. Now such seeding drills are exported to dozens of foreign countries.

However, the most common domestic beet seeder with mechanical seeding machines ССТ-12В at the moment does not withstand competition with pneumatic type drills both Western European and their analogs of domestic production.

The article presents the results of comparative field experimental studies of beet seeders of mechanical and pneumatic type on the parameters of seedlings placement accuracy.

Key words: sugar beet, seeding machine, seed, seed rate, ladder, seedling, coefficient of variation, germination ability.

Introduction

Sowing is the most responsible process of sugar beet cultivation, which ensures the uniformity of seedling along the length of the line at a given number in the area of sowing, which ultimately determines the level of productivity of the crop.

Formulation of problem

Modern mechanized technologies of sugar beet production provide the seeding of seed at the final density so that on each meter of the length of the line get 5,5-6,0 evenly spaced seedling of plants. It is very important to correctly, determine the seed seed rates, taking into account such factors as quality of seeds (laboratory germination ability, single-growth and germination energy must be at least 95%), the presence of pests and diseases, the level of litter field with weeds, etc. Under such conditions, the coefficient of variation of the placement of seeds V_s, as the characteristics of the uniformity of the intervals between them, will obviously deteriorate when the seedling (V_{sl}) are obtained.

Analysis of recent research results

The statistical index is the coefficient of variation, which is the ratio of the mean square deviation to the average arithmetic variation series (%), used by domestic and foreign researchers since the 70s of the last century to characterize the uniformity of intervals between seeds (V_s) or plants (V_{sl}) of sugar beets along the line.

Prof. Savich P.V. and Ph.D. Palamarchuk V.I. (All-Ukrainian Scientific Institute Of Breeding, Kyiv) first established the following coefficients depending on the different values of the field germination ability of seeds [1-3]:

$$V_{sl} = \sqrt{\frac{P - (1 - V_s)^2}{P}}$$

where P – field germination ability of the seed.

In articles by Makovetsky O. A. [4, 5] the mathematical dependence of the average mass of root crop from the value of the intervals to neighboring beets in the row of beets during the harvesting period is given for the first time (1978):

$$y = y_{max}\,(1 - e^{-k\bar{l}})(e^{-k\,\frac{l_2-\bar{l}}{\bar{l}}}),$$

$$\bar{l} = \frac{l_1+l_2}{2},$$

where l_1 – interval to the previous plant in a row;

l_2 – interval to the next plant in a row;

e – the basis of the natural logarithm;
k – rate of growth.

In 1985, Shapoval M.P. (AUSIB, Kyiv) found that the most uniform (18-20 cm spacing) plants were located in experimental variants, where the seed rate per 10-12 seed per 1 m row of plant density has been manually formed. The coefficient of variation of intervals between plants V_{sl} was 60% and 60,4% for the seed rate of 15-17 seeds and the descaling of USMP-5,4 seedlings, followed by manual checking [6].

Scientists of Russia [7-9] and Western European [10-12] also confirm that the uniform spreading of seeds and plants in rows significantly affects the productivity of sugar beets. With a significant uneven spreading of sugar beet plants before harvesting (the coefficient of variation of intervals between plants in the lines $V_{sl} \approx$ 90-100%), compared to the even spreading, the productivity of sugar beets may decrease by 18-20%. Therefore, increasing the uniformity of seed sowing and distribution of plants in rows is one of the important factors in increasing the productivity of sugar beet [9].

Summarization and analysis of the results of the experiments conducted allowed authors to obtain a simple and correct formula for calculating the value of V_{sl} [8]:

$$V_{sl} = \sqrt{1 - P_l \cdot 0{,}9}$$

where P_l – laboratory germination ability of the seed.

It was also established that the expected value of sugar beet yields can be determined by the formula [8, 12]:

$$R_{pp} = [0{,}95\,(V_{sl} - 0{,}35)\cdot 0{,}4]\cdot 100\ \%,$$

where R_{pp} – coefficient of realization of productivity potential (root crop productivity).

Zenin L. S. proves that there is an average connection between seeding norm, laboratory and field germination ability of seeds and standing density, which allows determining the optimum seed rate for obtaining given density (close to 100-110 thousand pcs / ha) of standing density. There it the probability of obtaining seedlings (field germination ability of the seed) *P* depends on germination ability P_l and from the conditions affecting the appearance of seedlings [8].

In the book edited by prof. Dieter Shpaar [12] argues that, on average, under normal favorable conditions, from 100 seeds appear about 90 seedlings. In this case, field germination ability the seed $P \approx 0{,}9\,P_l$. That is, if the seed norm *N* is known, then the expected number of seedlings Q_{sl} can be calculated:

$$Q_{sl} = N \cdot P$$

However, not all derived seedlings are stored in the future. For various reasons, about 10% of them rot. As a result, when seeding a certain norm of seed per hectare (*N*), the expected density of standing beet plants (*G*) can be determined by the formula:

$$G = N \cdot P_l \cdot 0{,}8$$

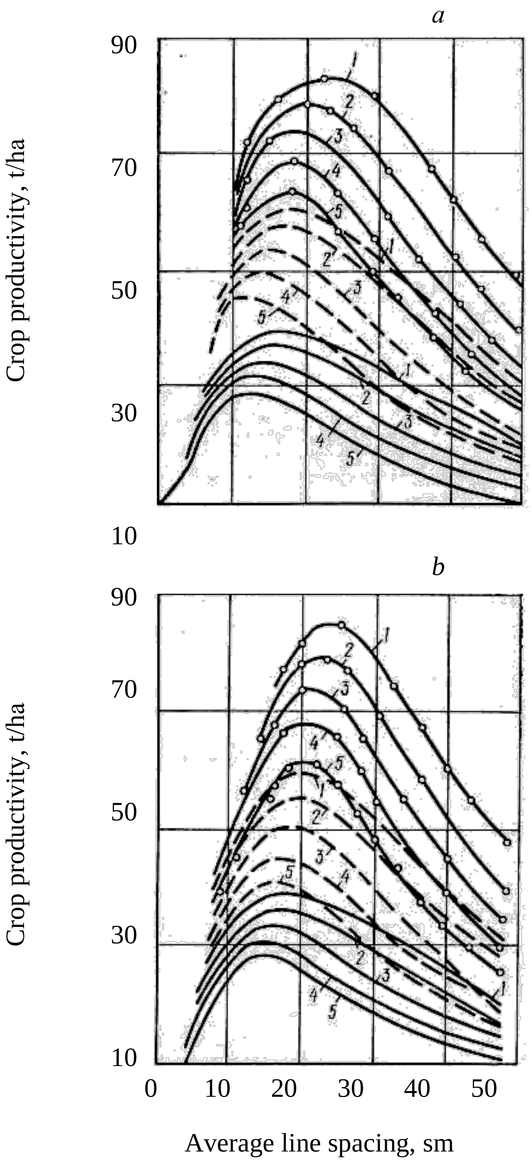

Fig. 1. Dependence of sugar beet crop productivity on density and uniformity of plant placement: a - after the formation of the density of planting; b - before harvesting; coefficient of variation of intervals: 1 - 25%; 2 - 50%; 3 to 75%; 4 to 100%; 5 to 125%; Root weights, g: — 500, – – 750, –°– 1000

Consequently, the analysis of the results of the well-known theoretical and experimental studies showed that the following formulas for determining the norm of seed sowing, calculated on the final density of plant standing is [8]:

$$N = \frac{100}{P_l \cdot 0{,}8}.$$

The obtained mathematical dependence allows us to calculate the seed rate as a linear meter of a row, and per hectare for different widths of row spacings.

Among the papers on such subjects the Ph.D. work of V. M. Sinchenko [13] deserves the attention, where experimentally grounded and theoretically proved interrelation between the density of standing, the uniformity of plant (by the coefficient of variation) after the formation of the density of standing and before collection, the mass characteristics of the roots are obtained, which prove the significance of the effect of uniformity of spreading plants on the yield of root crops.

In particular, according to the results of studies of model crops V. M. Sinchenko at an average interval of 20-25 cm and reducing the coefficient of variation of intervals between plants from 50% to 25% increases the yield of root crops before harvesting at 4,7-5,3 t/ha [13] (Fig. 1).

However, the question of the dependence of the magnitude of the intervals between seeds from the type of seeding machine (mechanical or pneumatic) is not sufficiently studied.

Purpose of research

The purpose of the research is to detect the influence of the type of seeding machine of domestic and foreign beet seeders on the accuracy of the placement of sown seeds, and, consequently, plant seedlings, along the length of the line. The criterion for evaluation is a statistical index - the coefficient of variation.

Results of research

Unlike mechanical type seeders, the principle of the system of domestic pneumatic seed drills is that, similar to the Western European seeding machine, for example, seeders UPS-12 [14, 15] (the plant "Red Star") works on the principle of dilution of the air that is created in chambers of a fan that is driven from the tractor's power take-off shaft. The seed, located in the zone of the digging chamber of the seed disk, passing through the dilution zone, is sucked to its holes. Equipped with a mechanism for adjusting, the puller removes unnecessary seeds leaving only one on each disk aperture. With the help of the puller, each separated seed from seeding disk is transmitted to a chamber wheel, the outer diameter of which is larger than the diameter of the disc with apertures. The seed is transferred to the zone of atmospheric pressure, where it separates from the hole and falls into the furrow, previously created in the soil by drill coulter point. The velocity of the chamber wheel is coordinated with the speed of the unit so that during the laying of seeds in a narrow wedge-shaped seed box there was no impulse its sliding and galloping the bottom of the seedbed. Seeding system of pneumatic seeders reliably ensures single seizure of seed, putting them in the desired interval, that is, the optimal accuracy of their placement in the line, even for sowing at high speed.

Comparative bench surveys were preceded by a study of a mechanical seeding machine and pneumatic with a mechanical drive of a seed disk. Seeds of various species (dragged, inlaid) were sown on a sticky tape that evenly moved, simulating the field. Of course, the pass was excluded. Measuring and calculating the average interval between seeds has been performed.

The results of research and long-term state tests conducted at UkrNIIPVT n. a. L. Pogorely showed that pneumatic seed drills, both foreign and domestic, provide higher uniformity of seedling placement along the line than the best among domestic seed drills SST-12V with mechanical sowing devices (Table 1-2).

The value of the coefficient of variation in the value of intervals between plants for each of the seedlings in terms of years is somewhat different because the conditions of sowing, operating modes of machines, the quality of their production, as well as the accuracy of technological adjustments in different years were uneven. Therefore, for the convenience of comparing seeders in relation to each of them, the average values of the coefficients of variation of intervals between plants are determined.

Table 1. Indicators of pneumatic seeders.

Indicators	Brands of seeders											
	"Multicorn"						SU-12					
Working speed, m/s	1,00	1,50	2,00	1,00	1,50	2,00	1,00	1,50	2,00	1,00	1,50	2,00
Estimated seeding rate, pcs/lm	8 - 10			12 - 14			8 - 10			12 - 14		
Average interval between plants, cm	13,7/11,4	12,4/12,1	15,3/13,8	9,4/8,8	10,9/14,9	10,4/12,1	12,4/13,7	12,8/13,0	13,5/12,9	9,4/10,7	10,9/11,2	11,2/12,6
Coefficients of variation, %	46,9/36,6	49,8/45,7	59,4/39,8	47,5/38,3	54,2/37,2	64,2/59,3	48,5/42,4	52,2/47,8	67,1/48,2	49,0/43,5	53,6/49,4	64,7/50,8
Type of seeding device	Pneumatic with mechanical drive of seed disk											

Table 2. Indicators of mechanical seeders

Indicators	Brands of seeders					
	SST-12V					
Working speed, m/s	1,00	1,50	2,00	1,00	1,50	2,00
Estimated seeding rate, pcs/lm	8 - 10			12 - 14		
Average interval between plants, cm	10,7/12,3	13,3/14,7	13,5/14,8	11,5/10,8	10,7/9,3	10,2/10,6
Coefficients of variation, %	79,6/65,9	79,9/67,9	84,6/73,4	84,3/81,3	86,7/86,9	94,4/89,4
Type of seeding device	Mechanical					

Note. The numerator shows the data using ordinary inlaid seeds of 4,5-5,5 mm fraction, in the denominator - dragged seeds of the same fraction.

The value of the coefficient of variation of the interval between plants for each of the seeders in the context of years is somewhat different in that the conditions for sowing, the operating modes of the machines, the quality of their manufacture, and the accuracy of technological adjustments in different years were not the same. Therefore, for the convenience of comparing the seeders, for each of them the averaged values of the coefficients of variation of the intervals between plants are determined.

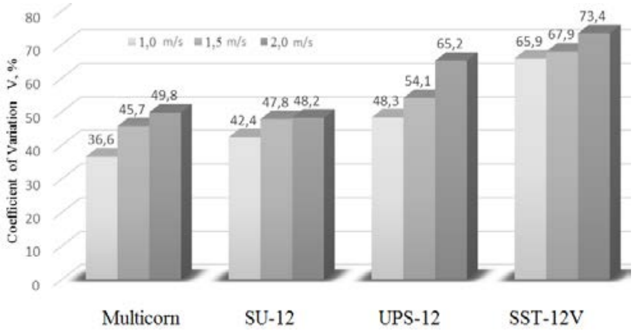

Fig. 2. Influence of the movement speed of seed drills with a seeding rate of 8-10 pcs/m by the value of the coefficient of variation of seedling placement (Fraction of dragged seed of 4,5-5,5 mm).

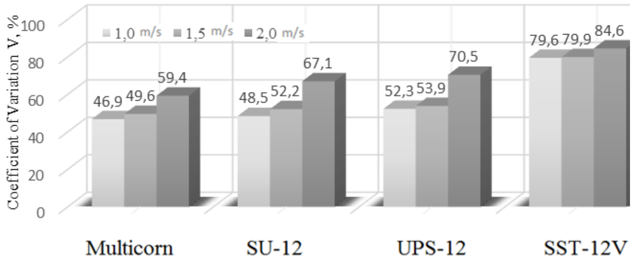

Fig. 3. Influence of the movement speed of seed drills with a seeding rate of 8-10 pcs/m by the value of the coefficient of variation of seedling placement (Fraction of inlaid seed of 4,5-5,5 mm).

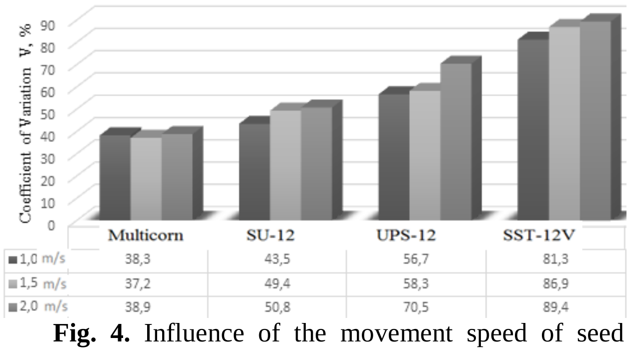

Fig. 4. Influence of the movement speed of seed drills with a seeding rate of 12-14 pcs/m by the value of the coefficient of variation of seedling placement (Fraction of dragged seed of 4,5-5,5 mm).

The average coefficient of variation V_{sl} of pneumatic seeders at the sowing of draggedseeds at a norm of 8-10 pcs/m is 49,1%, and SST-12V seeders – 69,2%, for sowing inlaid seeds, respectively, 56,7% and 81,4%.

It should be noted that the domestic pneumatic seeders SU-12 and UPS-12 are slightly inferior to the "reference" German seeders "Multicorn" by the coefficient. The coefficient of variation of intervals between the seedlings of the named seeders on average was 48,6%, 53,9% and 41,9% [15].

Statistical processing of the obtained data showed that with an increase in the seed drill speed Y (1,0–2,0 m/s) and a seed rate N (5–11 pcs/m), the uniformity of seed placement in the soil along the length of the line worsens, and the dependence of from changes in stack layout (%) described by regression models [16]:

$$V_{sl} = a + a_1Y + a_2YN + a_3/Y,$$

or:

$$V_{sl} = 41{,}82Y + 0{,}89YN + 63{,}87/Y - 92{,}5,$$ % (dragged seeds, 3,5–4,5 mm fraction);

$$V_{sl} = 41{,}69Y + 0{,}90YN + 63{,}45/Y - 94{,}1,$$ % (dragged seeds–4,5–5,5мм);

$$V_{sl} = 41{,}20Y + 0{,}91YN + 63{,}02/Y - 87{,}2,$$ % (inlaid seeds– 3,5–4,5 мм);

$$V_{sl} = 41{,}30Y + 0{,}90YN + 63{,}04/Y - 88{,}3,$$ % (inlaid seeds– 4,5–5,5мм).

The advantages of pneumatic seed drills are significant in the case of sowing of draggedseeds (Fig. 2, Fig. 4), but they were also found when sowing inlaid seeds (Fig. 3, Fig. 5), and both fractions 4,5-5,5 mm and fractions 3,5-4,5 mm.

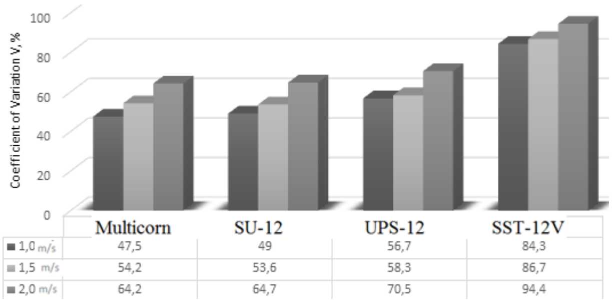

Fig. 5. Influence of the movement speed of seed drills with a seeding rate of 12-14 pcs/m by the value of the coefficient of variation of seedling placement (Fraction of inlaid seed of 4,5-5,5 mm).

Conclusions

A significant advantage in terms of the coefficient of variation of placement of shoots of sugar beet along the line in front of the mechanical type seeders (SST-12V, etc.) are pneumatic seeders of domestic (UPS-12, SU-12) and in particular, the German ("Multicorn") production (on average 49,1% (41,9% – in "Multicorn") against – 69,2%).

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ДОСЛІДЖЕННЯ ПОКАЗНИКІВ РОЗМІЩЕННЯ СХОДІВ ЦУКРОВИХ БУРЯКІВ ДЛЯ ПОСІВУ НАСІННЯ МЕХАНІЧНИМИ І ПНЕВМАТИЧНИМИ СІВАЛКАМИ

М. П. Волоха

Анотація. Щільність постійного і рівномірного розподілу рослин по довжині лінійного основних факторів підвищення урожайності та вмісту цукру в цукрових буряках. Це доведено з 70-х років минулого століття у дослідженнях вітчизняних вчених Інституту біоенергетичних культур і цукрових буряків (Київ) і Всеросійського науково-дослідного інституту цукрових буряків і цукру (Рамонь, Воронезької області) і західно-європейських вчених.

Передумовою для рівномірності укладання буряків є забезпечення рівномірності інтервалів між посівні насіння, які в основному забезпечується двома факторами. Вони досконаліcть висіваючий апарат і польову схожість насіння, як можна ближче до лабораторних умовах.

У 90-х, цукрових буряків посіяно в Україні в основному сівалки механічного типу ССТ-12А та модернізованих ССТ-12Б і ССТ-12В з розробленою УкрНДІСГОМ (Харків), Кіровоградський ІПК та Інституту біоенергетичних культур і цукрових буряків і виробництва, ВАТ Червона Зірка (Кропивницький).

В ССТ-12В сівалка виконує гранульованих добрив одночасно з посівом. У комплексі з живильником ПОМ-630-1 він здійснює введення газу рідких комплексних добрив або інсектицидів в зоні ліній. Використання 18-рядна сівалка ССТ-18В порівняно з 12-лінія ССТ-12В дозволяє скоротити

строки посіву. Завдяки цим перевагам, на 18 ряду і ряду 24 дрилі були розроблені в Кіровоградській ЧКВ. Зараз такі висіву сівалки експортується в десятки зарубіжних країн.

Однак, найбільш поширеним на вітчизняних буряків сівалки механічні сівалки ССТ-12В в даний момент не витримує конкуренції з пневматичним тип дрилі Західної Європи та їх аналоги вітчизняного виробництва.

У статті представлені результати порівняльних польових експериментальних досліджень бурякової сівалки механічного та пневматичного типу на параметри сіянців точність розміщення.

Ключові слова: цукрові буряки, сівалка, насіння, норма висіву, сходи, розсада, коефіцієнт варіації, схожість.

ИССЛЕДОВАНИЕ ПОКАЗАТЕЛЕЙ РАЗМЕЩЕНИЯ ВСХОДОВ САХАРНОЙ СВЕКЛЫ ДЛЯ ПОСЕВА СЕМЯН МЕХАНИЧЕСКИМИ И ПНЕВМАТИЧЕСКИМИ СЕЯЛКАМИ

М. П. Волоха

Аннотация. Плотность постоянного и равномерного распределения растений по длине линейного основных факторов повышения урожайности и содержания сахара в сахарной свекле. Это доказано с 70-х годов прошлого века в исследованиях отечественных ученых Института биоэнергетических культур и сахарной свеклы (г. Киев) и Всероссийского научно-исследовательского института сахарной свеклы и сахара (Рамонь, Воронежской области) и западно-европейских ученых.

Предпосылкой для равномерности укладки свеклы является обеспечение равномерности интервалов между посевные семена, которые в основном обеспечивается двумя факторами. Они совершенство высевающий аппарат и полевую всхожесть семян, как можно ближе к лабораторных условиях.

В 90-х, сахарной свеклы посеяно в Украине в основном сеялки механического типа ССТ-12А и модернизированных ССТ-12Б и ССТ-12В с разработанной UkrNDISGOM (Харьков), Кировоградский ИПК и Института биоэнергетических культур и сахарной свеклы и производства ОАО Червона Зирка (Кропивницкого).

В ССТ-12В сеялка выполняет гранулированных удобрений одновременно с посевом. В комплексе с питателем пом-630-1 он осуществляет введение газа жидких комплексных удобрений или инсектицидов в зоне линий. Использование 18-рядная сеялка ССТ-18В по сравнению с 12-линия ССТ-12В позволяет сократить сроки посева. Благодаря этим преимуществам, на 18 ряду и 24 ряда дрели были разработаны в Кировоградской ЧКВ. Сейчас такие высева сеялки экспортируется в десятки зарубежных стран.

Однако, наиболее распространенным на отечественных свеклы сеялки механические сеялки ССТ-12В в данный момент не выдерживает конкуренции с пневматическим тип дрели Западной Европы и их аналоги отечественного производства.

В статье представлены результаты сравнительных полевых экспериментальных исследований свекловичной сеялки механического и пневматического типа на параметры сеянцев точность размещения.

Ключевые слова: сахарная свекла, сеялка, семена, норма высева, рассада, коэффициент вариации, всхожесть.