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INFLUENCE OF AGROTECHNICAL FACTORS ON SUGAR CONTENT OF SUGAR BEET ROOTS UNDER IRRIGATION

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The article presents the results of research on the influence of agrotechnical factors on the sugar content of sugar beet roots under irrigation.

Sugar beet (Beta vulgaris) occupies an important place among the crops grown in Ukraine. It is an important sugar crop due to its relatively short growing season and low fertilizer and water requirements compared to sugar cane. The main root of beet contains 13-22% sugar. Increasing sugar yields is an important factor to meet the demand for sugar or at least to reduce the gap between sugar production and consumption in Ukraine.

The quality of sugar beet root crops depends on a combination of factors that can be conditionally placed in the following sequence: soil and climatic conditions, weather conditions, fertilizers, harvesting time, plant protection against pests, diseases and weeds, place in the crop rotation, sowing time, plant density, and variety characteristics.

The aim of the research was to study the influence of agronomic factors on the quality of sugar beet roots under irrigation.

The main objectives of our research were to determine the sugar content of sugar beet roots under different agronomic factors during irrigation.

Field experiments were conducted in the Kherson region in the zone of the Ingulets irrigated massif. The soil cover is represented by dark chestnut slightly saline medium loamy soils.

The following factors and their variants were included in the experimental design:

Factor A – plowing to a depth of 20-22 cm and 28-30 cm

seeding rate of similar seeds: 6; 9 and 12 million pcs/ha.

Factor B – fertilizer background: no fertilizers, N150P150K60, Manure 40t/ha + N150P150K60, Manure 40 t/ha.

Factor C – sowing dates: the first term – at a soil temperature at the depth of seed placement (4-5 cm) – 6-8°C; the second – ten days, the third – 20 days after the first term;

Factor D – plant density: 90, 110 and 130 thousand/ha.

Based on the results of the research, the following conclusions can be drawn: to obtain high-quality sugar beet roots with a sugar content of 16%, plowing should be carried out on dark chestnut irrigated soils to a depth of 20-22 cm, organic and mineral fertilizers should be applied at a rate of 40 t/ha of manure + N150P150K60, sowing should be carried out at a soil temperature of 8-9°C and plant density should be formed at the level of 110 thousand/ha.

Key words: *sugar beet, plowing depth, nutrition background, sowing time, plant density, sugar content.*

Минкіна Г.О. Вплив агротехнічних факторів на цукристість коренеплодів буряку цукрового при зрошенні

В статті наведено результати досліджень з вивчення впливу агротехнічних факторів на цукристість коренеплодів буряку цукрового при зрошенні.

Серед вирощуваних на Україні сільськогосподарських культур важливе місце займає цукровий буряк (Beta vulgaris). Він є важливою цукроносною культурою завдяки відносно короткій тривалості його вегетаційного періоду та низьким потребам у добривах та воді, порівняно з цукровою тростиною. Головний корінь буряка містить 13-22% цукру. Збільшення виходу цукру є важливим фактором для задоволення попиту на цукор або принаймні для зменшення розриву між виробництвом та споживанням цукру в Україні.

Якість коренеплодів цукрових буряків залежить від поєднання комплексу факторів, які умовно можна розмістити в такій послідовності: ґрунтово-кліматичні умови, погодні

умови, добрива, строки збирання, захист рослин від шкідників, хвороб і бур'янів, місце в сівозміні, строки сівби, густота стояння рослин, особливості сорту.

Метою досліджень було вивчити вплив агротехнічних факторів на якість коренеплодів буряку цукрового при зрошенні.

Основними завданнями наших досліджень було встановити цукристість коренеплодів буряку цукрового за різних агротехнічних фактори при зрошенні.

Польові досліди проводилися в Херсонській області в зоні Інгулецького зрошуваного масиву. Ґрунтовий покрив представлений темно-каштановими слабо солонцевими середньо суглинистими ґрунтами.

У схему досліду були включені наступні фактори і їх варіанти:

Фактор А – оранка на глибину 20-22см та 28-30 см

норма висіву схожих насінин: 6; 9 і 12 млн. шт / га.

Фактор В – фон живлення: без добрив, $N_{150}P_{150}K_{60,}$ Гній 40т/га +

$N_{150}P_{150}K_{60}$ Гній 40 т/га.

Фактор С – строки сівби: перший строк – при температурі ґрунту на глибині загортання насіння (4-5 см) – 6-8°С; другий – через десять, третій – через 20 днів після першого строку;

Фактор Д – густота стояння рослин: 90, 110 та 130 тис./га.

За результатами проведених досліджень можна зробити такі висновки: для одержання якісних коренеплодів цукрових буряків з вмістом цукру на рівні 16%, на темно-каштанових зрошуваних ґрунтах проводити оранку на глибину 20-22 см, вносити органо-мінеральні добрива нормою 40 т/га гною + $N_{150}P_{150}K_{60}$, проводити сівбу при температурі ґрунту 8-9°С та формувати густоту стояння рослин на рівні 110 тис./га.

Ключові слова: *буряк цукровий, глибина оранки, фон живлення, строки сівби, густота стояння рослин, цукристисть.*

Statement of the problem. The tasks of modern agriculture are the most productive use of all agricultural land to obtain high, high-quality and sustainable yields, create the necessary conditions for the systematic reproduction and improvement of soil fertility, rational use of natural and production resources, taking into account the optimization of water and nutrient regimes, soil and environmental protection in general.

Among the crops grown in Ukraine, sugar beet (Beta vulgaris) plays an important role. It is an important sugar crop due to its relatively short growing season and low fertilizer and water requirements compared to sugar cane. The main root of beet contains 13-22% sugar. Increasing sugar yields is an important factor to meet the demand for sugar or at least to reduce the gap between sugar production and consumption in Ukraine.

The cultivation of sugar beet and the production of sugar from the roots is decreasing from year to year. The needs of the national economy are not yet fully met by domestic sugar production.

In solving this problem, a significant role is given to the study of the influence of agrotechnical factors on the quality of sugar beet roots under irrigation.

The quality of sugar beet roots depends on a combination of factors that can be conditionally placed in the following sequence: soil and climatic conditions, weather conditions, fertilizers, harvesting time, plant protection against pests, diseases and weeds, place in the crop rotation, sowing time, plant density, and variety characteristics.

Therefore, scientific research aimed at studying the main agrotechnical methods of sugar beet cultivation under irrigation in the south of Ukraine, their impact on the quality of the crop, is relevant and of interest to agricultural production.

Analysis of recent research and publications. In recent years, the production of sugar beet roots in Ukraine has been insufficient.

Scientists believe that the methods and depth of soil cultivation do not significantly affect the sugar content of root crops. Thus, in the experiments of Buts O.V.,

Filonenko S.V., the sugar content in the shelf cultivation was 16.7, and in the non-shelf cultivation – 17.2%, in the experiments conducted on chestnut soils [3], respectively, 14.8 and 14.9% [2,3,4].

The positive effect of surface and shallow tillage on the accumulation of sugars in root crops is noted by Minkin M.V. Some researchers believe that the reason for the increase in sugar content in variants with surface, shallow and moldboardless tillage is the acceleration of technical maturation of root crops, slowing down the intensity of leaf and root mass growth in the second half of the growing season, which contributes to the fact that a significant part of the assimilants formed during photosynthesis was transported to root crops, where it was stored [3].

In the experiments conducted on black soil, the maximum yield of sugar beet roots and sugar yield was obtained when 210 kg/ha of NPK combined with 30 t/ha of manure was applied for autumn plowing. A number of authors have noted the maximum increase in sugar beet yield and sugar harvest under the influence of complete mineral fertilization with different types of organic fertilizers [5].

Fertilization helps to increase sugar beet yields, but too high rates of fertilizers, especially mineral fertilizers, are economically unprofitable, as they reduce sugar content, do not increase harvesting, and result in low rates of return on investment and fertilizers.

Thus, according to [5], the application of mineral fertilizers at rates of 60 and 90 kg NPK did not negatively affect the accumulation of sugars, and when the rate was increased to 120 kg NPK, sugar content decreased by 0.4%. In the experiments conducted on dark chestnut soils under irrigation, the sugar content of root crops in unfertilized areas was 16.1%, with the introduction of N80P120K60 – 15.9 and against the background of N180P120K60 – 15.1%; sugar yield – 65.7, 79.0 and 80.0 c/ha, respectively [5].

In the zone of unstable moisture of the Forest-Steppe of Ukraine, on black soil, an increase in nitrogen from 85 to 147 kg/ha increased sugar beet yield by 1.1 t/ha, and sugar content – reduced by 0.5%; an increase in phosphorus and potassium from 128 and 127 to 210 and 220 kg/ha did not change sugar content, but only increased the yield by 0.3 t/ha. However, despite the decrease in sugar content with mineral fertilizers, all scientists note an increase in sugar yield per hectare due to higher yields.

The effectiveness of fertilizers depends on how they are applied. According to the authors, more favorable conditions for the use of fertilizers are created when they are locally placed in the soil. This method of fertilizer application can reduce the rate of fertilizer application by 30%.

The use of mineral fertilizers significantly increases sugar beet yields and sugar harvest against the background of organic fertilizers. In the experiments conducted at the Khmelnytskyi Experimental Station on podzolic black soil, plowing 30 t/ha of manure + N140P140K140 increased sugar beet yield by 5.1%, sugar yield by 0.6 t/ha (compared to the N140P140K140 variant), and by 8.1 and 1.4 t/ha (compared to the 30 t/ha of manure variant).

The sugar content of sugar beet roots is also influenced by the sowing time. Thus, according to [9], a one-day delay in sowing, compared to the optimal time, reduces the yield of root crops by 5-7, and sugar harvest – by 1-2 c/ha, by 5-6 days – by 21-71 and 7-18 c/ha, respectively.

There is a direct relationship between plant density, yield and quality indicators of sugar beet, the results of the experiment [11] show that the highest sugar content of root crops 17.39% was when the plants were thickened to 96 thousand/ha, with a decrease in the number of plants to 85 thousand/ha – sugar content was 17.30, and when the plants were thickened to 114 thousand/ha, sugar content decreased to 17.16%.

Statement of the task. One of the biological features of sugar beet is the dependence of sugar content in roots on the seeding rate of seeds and fertilizers, tillage and sowing time, but in the literature there are data that both confirm and refute this statement.

The aim of the research was to study the influence of agronomic factors on the quality of sugar beet roots under irrigation.

The main objectives of our research were to determine the sugar content of sugar beet roots under different agronomic factors during irrigation.

Field experiments were conducted in the Kherson region in the zone of the Ingulets irrigated massif. The soil cover is represented by dark chestnut slightly saline medium loamy soils.

The following factors and their variants were included in the experimental design:

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Factor C – sowing dates: the first term – at a soil temperature at the depth of seed placement (4-5 cm) – 6-8°C; the second – ten days, the third – 20 days after the first term;

Factor D – plant density: 90, 110 and 130 thousand/ha.

Summary of the main research material. The data on the influence of agrotechnical factors on sugar content of sugar beet roots are given in Table 1.

Sugar beet does not have self-regulatory mechanisms to promote sugar accumulation and depends on external stimuli and climatic factors such as solar radiation, temperature, humidity and daylight hours, which largely determine the type of growth and the amount of sugar accumulated in the roots.

On average, the sugar content in the experiment was in the range of 14.4-16.3%, depending on the depth of plowing, nutritional background, sowing time and plant thickening. The depth of plowing did not significantly affect the sugar content in root crops.

When comparing different nutritional backgrounds, it should be noted that without the use of fertilizers, depending on the depth of plowing, sowing time and planting density, the sugar content ranged from 15.4 to 16.3% and was the highest, unlike fertilized variants.

Thus, when applying mineral fertilizers at a rate of N150P150P60, the sugar content in root crops was at the level of 14.4-15.4%, it decreased in plowing areas to a depth of 20-22 cm at the first sowing date, depending on the plant density by 0, 7-0.8%, or 4.6-5.3 relative percent, the second – by 0.3-0.9, or 1.9-6.0, and the third – by 0.2-0.8%, or 1.3-5.4%, respectively, compared to the unfertilized variant. In the variant of plowing to a depth of 28-30 cm, this decrease was by 1.0%, or 6.5-6.7% relative percentage, in the first term of sowing, by 0.8-1.1, or 5.3-7.5, and in the second term by 0.8-1.2%, or 5.3-8.3 relative percentage, respectively.

The use of organic-mineral fertilizers for sugar beet contributed to a decrease in the sugar content of root crops, depending on the depth of plowing, sowing time and plant density by 0.1-0.8% compared to the unfertilized background, and an increase in comparison with the variant of mineral fertilizers by 0.1-0.6%. On the background of organic fertilizers only, the sugar content in root crops was almost the same compared to the unfertilized variant, but significantly increased compared to the variant of mineral fertilizers only.

Table 1

Sugar content of sugar beet roots depending on the studied factors, %

Power background	Sowing period	Plant density, thousand/ha		
		90	110	130
Plowing to a depth of 20-22 cm				
No fertilizers	First	15,8	15,9	16,2
	Second	15,8	15,7	15,7
	Third	15,6	15,4	15,5
$N_{150}P_{150}K_{60}$	First	15,0	15,2	15,4
	Second	14,9	15,1	15,4
	Third	14,8	15,0	15,3
Manure 40 tons/ha + $N_{150}P_{150}K_{60}$	First	15,2	15,5	15,7
	Second	15,1	15,3	15,6
	Third	15,0	15,1	15,3
Manure 40 tons/ha	First	15,6	15,8	16,0
	Second	15,5	15,7	16,0
	Third	15,4	15,6	15,7
Plowing to a depth of 28-30 cm				
No fertilizers	First	15,9	16,1	16,3
	Second	15,8	16,0	16,0
	Third	15,6	15,8	15,8
$N_{150}P_{150}K_{60}$	First	14,9	15,1	15,3
	Second	14,7	15,0	15,2
	Third	14,4	14,7	15,0
Manure 40 tons/ha + $N_{150}P_{150}K_{60}$	First	15,4	15,7	15,9
	Second	15,0	15,5	15,8
	Third	14,8	15,1	15,3
Manure 40 tons/ha	First	15,8	16,0	16,2
	Second	15,6	15,9	16,0
	Third	15,3	15,7	15,9

The accumulation of sugars was also influenced by the timing of sowing, the later the sowing was carried out, the lower the sugar content was. This decrease was especially observed in the third sowing period, i.e. 20 days later than the recommended time. Thus, at the last sowing date, the sugar content in root crops decreased by 0.1-0.7% compared to the first, depending on the depth of plowing, nutrition background and plant density.

The accumulation of sugars in root crops was also influenced by the density of plants, as can be seen from the data, the more plants per hectare, the higher the sugar content of root crops. Thus, with an increase in the number of plants per hectare from 90 to 110 thousand, sugar content increased depending on the depth of plowing, nutrition background and sowing dates by 0.1-0.5%, and with an increase to 130 thousand – by 0.1-0.8%.

Based on the experiments conducted, it can be concluded that the depth of plowing did not significantly affect the sugar content of root crops. The accumulation of sugars was mainly influenced by fertilizers, sowing dates and crop thickening. The highest accumulation of sugars in root crops – 15.3-16.3% was in the variants without fertilizers at the first sowing date and the formation of plant density at the level of 110-130 thousand plants per hectare. Similar results were obtained against the background of organic-mineral and organic fertilizers.

Conclusions. Thus, agrotechnical practices have an impact on the sugar content of beets, and they can be adjusted to provide the right conditions for maximizing the quality of raw sugar.

Therefore, we recommend that to obtain high-quality sugar beet roots with a sugar content of 16%, on dark chestnut irrigated soils, plowing should be carried out to a depth of 20-22 cm, organic and mineral fertilizers should be applied at a rate of 40 t/ha of manure + N150P150K60, sowing should be carried out at a soil temperature of 8-9°C and plant density should be formed at the level of 110 thousand/ha.

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