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PRODUCTIVITY OF GRAIN-BEET ROTATIONS DEPENDING ON TILLAGE AND FERTILIZATION IN THE FOREST-STEPPE OF UKRAINE

ПРОДУКТИВНІСТЬ ЗЕРНОБУРЯКОВИХ СІВОЗМІН ЗАЛЕЖНО ВІД ОБРОБІТКУ ҐРУНТУ ТА УДОБРЕННЯ В УМОВАХ ЛІСОСТЕПУ УКРАЇНИ

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Abstract. *For the first time the effect of tillage methods on sugar beet productivity, yields of winter wheat, spring barley, sainfoin depending on their fertilizers backgrounds in short-term farming rotation has been determined in the conditions of the Left-Bank Forest-Steppe of Ukraine during a long-term stationary experiment on typical weakly solonetzic black soil. The field studies were carried out in the stationary experiment of Veselopodilsk experimental and plant breeding station of the Institute of Bioenergy Crops and Sugar Beet of the National Academy of Agrarian Sciences of Ukraine during 2015–2020. The highest productivity of sugar beet was obtained in short-term crop rotation under the conditions of ploughing to a depth up to 30–32 effected by applying* $N_{140}P_{90}K_{90}$ *+ straw: yield of root crops and sugar collection were 39.9 t/ha and 6.83 t/ha, respectively. In the study it is recommended to use a combined system of basic tillage which provides ploughing to the depth of 30–32 cm for sugar beets and subsurface or shallow tillage for growing grain and fodder crops.*

Keywords: *sugar beet, winter wheat, spring barley, sainfoin, tillage, fertilization, farming rotation.*

Introduction.

In the condition of intensive farming it is important to increase the productivity of crops affected by efficient tillage and fertilization, that have a positive impact on phytosanitary state of crops, physical and agrochemical properties of soil, its conservation and reproduction of fertility. Tsvei et al. [28] prove that tillage, as well as scientifically based crop rotation and a fertilization system, is an integral and important part of the technology of growing crops.

The long-term observations and analyses of Barshtein et al. [2] show that organic and mineral fertilizers have a full effect on the conditions required for cultivated plant growth and development. Under this influence, crop nutrition and efficiency of assimilating soil moisture are improved, crops grow more intensively, grain crops bushes and resist diseases and pests, unfavourable weather conditions, weeds, and the like. All this contributes to the growth of productivity and increases its stability and quality [3, 27].

Barshtein [1], Pastukh et al. [19] prove that the large amplitude of fluctuations in crop yields over the years depends on weather conditions. The introduction of scientifically based crop rotation, rational tillage methods and optimal fertilizer application rate can influence it positively. This will not only increase yields, but also stabilize ones as well.

The systematic use of shallow ploughing and subsurface tillage in rotations with sugar beets at their high concentration is unacceptable, especially without the introduction of a sufficient amount of organic and mineral fertilizers. However, the studies of Barshtein et al. [3] shows that the combination of shallow disk and subsurface tillage for grain crops with deep ploughing for sugar beets does not reduce their yield compared to mid-depth ploughing. The systematic use of shallow or subsurface tillage and fertilizers very little change crop productivity and efficiency as a whole.

For example, the efficiency of all crops and the productivity of grain-beet rotations significantly increase under the influence of fertilizers [10, 11, 12, 16, 18, 29]. A fertilization system should improve and supplement natural soil fertility in such a way as to fully satisfy the requirements of sugar beets in all nutrients of the planned harvest [30, 31].

Thus, the studies recommend using a combined system of basic tillage, which includes ploughing to 30–32 cm for sugar beets and subsurface or shallow tillage for growing grain and fodder crops [27].

Material and methods.

In the conditions of Veselopodilsk experiment and plant breeding station of the Institute of Bioenergy Crops and Sugar Beet of NAAS of Ukraine (Semenivka district, Poltava region) during 2015–2020 a long-term stationary experiment was conducted to study different methods of basic tillage for sugar beet, winter wheat, spring barley, sainfoin in short-term grain-beet rotations. The aim of the study was to determine rational tillage methods for crops in the conditions of the Left-Bank Forest-Steppe that ultimately would provide high productivity of beets, high yields of wheat, spring barley and sainfoin.

To achieve this goal, the following recordings, observations and analyses were carried out [22]:

1. There were phenological observations over sugar beet development during the growing season according to the methodology of the Institute of Bioenergy Crops and Sugar Beet. The time of the emergence of single, mass and full shoots, the

appearance of the first, second and third pairs of true leaves, the beginning of leaf closing at row spacing and inter-row spacing were noted. The beginning of the indicated phases of the development was considered to be the sowing period in which 10% of the plants had this trait.

2. The soil moisture was determined in the spring for the sowing period, during closing of leaves at inter-row spacing and before harvesting.

3. The water properties of the soil were determined.

4. The density of sugar beet sprouts was calculated. For this, in all variants in three repetitions, the plants were counted on three two-meter line segments, which were placed on the diagonal of each plot. At the same time, the number of weeds per 0.25 m2 was determined on these plots.

5. The calculation of the plant population of sugar beets was carried out after the formation of plantings before harvesting. The recording was carried out on two-meter line segments in three repetitions in all farming rotations.

6. The recording of the yields of winter wheat, spring barley, and sugar beets was carried out by the method of continuous combine harvesting of each plot with simultaneous weighing and subsequent recalculation per hectare. The crop density of sugar beets was additionally determined by total counting of root tubers during weighing.

7. The sugar content of root tubers and other technological indexes for the period of harvesting were determined by the cold digestion method using the automatic line «Venema» in samples of 24 root tubers taken on the registration plot.

Under the conditions of the experiment, the productivity of crops was evaluated by different methods of basic tillage and fertilization:

Variant 9: tillage – ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops (control); fertilization – without fertilizers, without straw.

Variant 10: tillage – ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops; fertilization – application of 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw.

Variant 11: tillage – ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops; fertilization – application of 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw.

Variant 12: tillage – ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops; fertilization – application of $N_{140}P_{90}K_{90}$ + straw.

Variant 15: tillage – to the depth of 30–32 cm for sugar beets and subsurface tillage at 20–22 cm for grain crops (a combined tillage method); fertilization – without fertilizers and without straw.

Variant 16: tillage – to the depth of 30–32 cm for sugar beets and subsurface tillage at 20–22 cm for grain crops (a combined tillage method); fertilization – application of 25 t/ha of manure + $N_{90}P_{90}K_{90}$ and without straw.

Variant 17: tillage – to the depth of 30–32 cm for sugar beets and subsurface tillage at 20–22 cm for grain crops (a combined tillage method); fertilization – application of 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw.

Variant 18: tillage – to the depth of 30–32 cm for sugar beets and subsurface tillage at 20–22 cm for grain crops (a combined tillage method); fertilization –

$N_{140}P_{90}K_{90}$ + straw.

Results.

The conducted research shows that productivity of sugar beets in short-term crop rotation depended on methods of basic tillage and a fertilization system. The lowest yield of sugar beets was obtained – 22.6 t/ha (Table 1), when ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background without fertilizers, without straw (var. 9).

Table 1

Productivity of sugar beets depending on methods of basic tillage and a fertilization system in short-term crop rotation, on average, during 2016–2019

Variant of experiment	Productivity of sugar beets		
	yield, t/ha	sugar content, %	sugar collection, t/ha
9	22,6	17,0	3,87
10	37,6	17,4	6,56
11	38,6	17,3	6,66
12	39,2	17,6	6,87
15	24,2	16,8	4,06
16	37,4	17,1	6,40
17	38,5	17,1	6,60
18	39,9	17,2	6,83
HIP_{05} general	0,9	0,6	0,23
HIP_{05} for factor A (tillage)	0,6	0,5	0,16
HIP_{05} for factor B (fertilization)	0,4	0,4	0,12

Author's research

The practice of ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background of applying $N_{140}P_{90}$ K_{90} + straw (var. 12) caused increases in the yield of sugar beets to the level of 39.2 t/ha. The practice of ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops, against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw for beets as well as against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ +straw (var. 11) resulted in the yields of beets at almost the same level, 37.6 and 38.6 t/ha respectively. It was due to the high level of soil supply with labile phosphorus and exchangeable potassium under the condition of applying the combination of organic and mineral fertilizers.

The practice of ploughing to the depth of 30–32 cm for sugar beets and flat loosening at 20–22 cm for grain crops (a combined tillage) against the background of without fertilizers and without straw (var. 15) resulted in decreases in the yield of sugar beets to the level of 24.2 t/ha. Under the conditions of combined tillage on fertilized backgrounds, the yield of sugar beets increased: applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw (var. 16) for beets – to 37.4 t/ha, applying $N_{90}P_{90}K_{90}$ + straw (var. 18) for beets – to 39.9 t/ha. The practice of ploughing to the depth of 30–32 cm for sugar beets in rotation and subsurface loosening the soil to the depth of 20–22 cm for grain crops against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ +straw (var. 17) for beets resulted in the yields of root crops of 38.5 t/ha.

In addition to the yield of sugar beets, their sugar content is an important indicator that is affected by tillage and fertilizer doses for beets [24, 25].

The results of our research show that when ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background of applying $N_{90}P_{90}K_{90}$ + straw (var. 12) for beets, sugar content of root crops was 17.6%. It was higher by 0.3% compared to ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw (var. 11) for beets, due to higher level of nitrogen (table 1). Under the conditions of ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw (var. 10) sugar content of root crops was 17.4 %.

The practice of ploughing to the depth of 30–32 cm for sugar beets and subsurface loosening at 20–22 cm for grain crops (combined tillage) against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw (var. 16) for beets as a well as against the background of applying 25 t/ha manure + $N_{90}P_{90}K_{90}$ +straw (var. 17) for beets resulted in the equal sugar content of beet root crops, 17.1 and 17.1%, respectively.

Thus, the practice of ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background of applying $N_{140}P_{90}K_{90}$ +straw for beets resulted in the highest sugar content of root crops of 17.6 %. The method of combined tillage against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw and 25 t/ha of manure + $N_{90}P_{90}K_{90}$ +straw contributed to the sugar content of root crops, 17.1 and 17.1 % respectively.

Sugar collection depended on methods of basic tillage for crops in rotation and a fertilization system for sugar beets. Ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background without fertilizers and without straw (var. 9) and ploughing to the depth of 30–32 cm for sugar beets and subsurface loosening of soil to the depth of 20–22 cm for grain crops against the background without fertilizers and without straw (var. 15) resulted in the lowest sugar collection, 3.87 and 4.40 t/ha, respectively (table 1). When ploughing to the depth of 30–32 cm for sugar beets and 20–22 cm for grain crops against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ without straw (var. 10) as well as applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw (var. 11), the sugar collection was almost at the same level, 6.56 and 6.66 t/ha, respectively. The practice of ploughing to the depth of 30–32 cm for sugar beets and subsurface loosening at 20–22 cm for grain crops against the background of applying 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw (var. 12) for beets resulted in the highest sugar collection of 6.87 t/ha.

The results of our research in short-term crop rotation show that winter wheat yield depended on methods of basic tillage and a fertilization system. The practice of subsurface loosening of soil to the depth of 20–22 cm for winter wheat against the unfertilized background without fertilizers, without straw, without haulm (var. 15) it was noted the lowest yield of winter wheat grain – 3.77 t/ha (table 2).

The practice of subsurface loosening of soil to the depth of 20–22 cm for winter wheat in one cycle of rotation with application of 6.25 tons of manure + $N_{33,8}P_{33,8}K_{33,8}$ without straw, without haulm (var. 16) per 1 ha of arable land, 6.25 of manure

$+N_{33,8}P_{33,8}K_{33,8}$ + straw + haulm (var. 17) and $N_{46,2}P_{33,8}K_{33,8}$ + straw + haulm (var. 18) provided significant yield of winter wheat to the level of 4.51; 5,02 and 4,56 respectively. That is, significant increase in winter wheat yield was observed during the practice of loosening of soil against fertilized backgrounds compared to unfertilized background. The practice of ploughing to the depth of 20–22 cm for winter wheat in one cycle of crop rotation with application of 6.25 tons of manure + $N_{33,8}P_{33,8}K_{33,8}$ without straw, without haulm per 1 hectare of arable land (var. 10), 6.25 of manure + $N_{33,8}P_{33,8}K_{33,8}$ +straw+ гичка (var. 11) and $N_{33,8}P_{33,8}K_{33,8}$ +straw+ haulm (var. 12) resulted in increases of the wheat yield to the level of 4.72, 4.95 and 5.01 t/ha, respectively, while against the unfertilized background without fertilizers without straw, without haulm (var. 9) the wheat yield was 3.85 t/ha. That is, when ploughing for winter wheat against fertilized backgrounds, increased wheat yield was observed compared to the unfertilized background. It should be emphasized that ploughing to the depth of 20–22 cm for winter wheat against the fertilized backgrounds (var. 10, 12) contributed to significant increases in the wheat yield by 0.21 and 0.45 t/ha, respectively, compared to subsurface loosening of soil the depth of 20–22 cm for wheat against the fertilized backgrounds (var. 16 and 18).

Table 2

Productivity of winter wheat depending on methods of basic tillage and a fertilization system in short-term crop rotation, on average, during 2015–2018

Variant of experiment	Productivity of winter wheat, t/ha
9	3,85
10	4,72
11	4,95
12	5,01
15	3,77
16	4,51
17	5,02
18	4,56
HIP_{05} general	0,28
HIP_{05} for factor A (tillage)	0,20
HIP_{05} for factor B (fertilization)	0,14

Author's research

It should be stressed that in many cases fertilizers are not applied for spring barley, relying on the activity of this crop to use the aftereffect. There is a real aftereffect, and the higher the rate of fertilizer applied for previous crops, the greater aftereffect is.

As we mentioned earlier, in the conducted experiment in short-term row, grain-row crop rotation for barley, it was practiced the ploughing to the depth of 20–22 cm, and barley was grown on the aftereffects of fertilizers applied for sugar beets. It was found that in crop rotation against the background without fertilizers, without straw, without haulm (var. 9) the lowest yield of barley was obtained – 3.77 t/ha (table 3).

The practice of application of 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw + haulm (var. 11) for sugar beets increased the spring barley productivity by 0.22 t/h in farming rotation with sainfoin. The process of growing barley against the background of without manure, without straw, without haulm (var. 27) in row farming rotation and against the background of without manure, without straw, without haulm (var. 45) in grain-row rotation resulted in the decreased barley productivity by 0.30 and 0.27 t/ha, respectively, compared to unfertilized background in crop rotation (var. 9). Under the conditions of row crop rotation for sugar beets, 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw + haulm (var. 29) in aftereffects increased the barley yield to the level of 3.92 t/ha, while under the conditions without fertilizers, without straw, without haulm (var. 27) the barley yield was only 3.07 t/ha. Under the conditions of grain-row rotation for sugar beets against the background of application of 25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw + haulm (var. 47) it was noted increased barley yield to 3.89 t/ha, which was 0.79 t/ha more than the background without fertilizers, without straw, without haulm (var. 45). It should be noted that the practice of application of 25 t/ha of manure + $N_{90}P_{120}K_{90}$ + straw + haulm for sugar beet had an aftereffect on barley cultivation. This contributed to the barley yield at the same level, 3.99; 3.92 and 3.89 t/ha, respectively, in crop rotations (var. 11), row rotations (var. 29) and grain-row rotations (var. 47) in farming rotation.

Table 3

Productivity of spring barley depending on ploughing and a fertilization system in short-term grain-beet rotation, on average, during 2017–2020

Variant	Type of farming rotation	Fertilization system (on the aftereffects of fertilizers applied for sugar beets)	Productivity of spring barley, t/ha
9	crop rotation	Without fertilizers, without straw, without haulm	3,37
11		25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw + haulm	3,99
27	row rotation	Without fertilizers, without straw, without haulm	3,07
29		25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw + haulm	3,92
45	grain-row rotation	Without fertilizers, without straw, without haulm	3,10
47		25 t/ha of manure + $N_{90}P_{90}K_{90}$ + straw + haulm	3,89
HIP_{05} general			0,30
HIP_{05} for factor A (tillage)			0,19
HIP_{05} for factor B (fertilization)			0,13

Author's research

Our research has shown that in short-term crop rotation under the conditions of ploughing to the depth of 20–22 cm for barley with intercropping of sainfoin against the background without fertilizers, without straw, without haulm (var. 9), the lowest yield of sainfoin hay was obtained – 4.98 t/ha (table 4).

The practice of ploughing to the depth of 20–22 cm for barley with intercropping of sainfoin under the conditions of application of $N_{33,8}P_{33,8}K_{33,8}$ + straw + haulm (variant 11) in one cycle of rotation per 1 ha of arable land contributed to increased productivity of sainfoin hay to 8.17 t/ha. The practice of ploughing to the depth of 20–22 cm for barley with intercropping of sainfoin under the conditions of application 6.25 tons of manure + $N_{33,8}P_{33,8}K_{33,8}$ without straw, without haulm as well as application of $N_{46,2}P_{33,8}K_{33,8}$ + straw + haulm (variant 12) in one cycle of rotation per 1 ha of arable land contributed to the productivity of sainfoin hay at the level of 7.98 and 6.70 t/ha, respectively.

Table 4

Productivity of sainfoin depending on methods of basic tillage for barley with intercropping of sainfoin and a fertilization system in short-term crop rotation, on average, during 2017–20120

Variant	Productivity of sainfoin hay, t/ha
9	4,98
10	7,98
11	8,17
12	6,70
15	4,83
16	8,62
17	8,82
18	7,83
HIP_{05} general	0,39
HIP_{05} for factor A (tillage)	0,21
HIP_{05} for B (fertilization)	0,15

Author's research

The practice of flat loosening of soil to the depth of 20–22 cm for barley with intercropping of sainfoin against the background of without fertilizers, without straw, without haulm (var. 15) resulted in decreased productivity of sainfoin hay to 4.83 t/ha. The practice of flat loosening of soil against fertilized backgrounds, the productivity of sainfoin hay increased: under the conditions of application of 6.25 tons of manure + $N_{33,8}P_{33,8}K_{33,8}$ without straw, without haulm (var. 16) in one cycle of rotation per 1 ha of arable land – up to 8.62 t/ha and under the conditions of application $N_{46,2}P_{33,8}K_{33,8}$ + straw + haulm (var. 18) in one cycle of rotation per 1 ha of arable land – up to 7.83 t/ha. The practice of flat loosening of soil the depth of 20–22 cm for barley with intercropping of sainfoin under the conditions of application of 6.25 tons of manure + $N_{33,8}P_{33,8}K_{33,8}$ + straw + haulm (variant 17) in one cycle of rotation per 1 ha of arable land, the productivity of sainfoin hay was 8.17 t/ha.

Discussion.

In different zones of beet production in Ukraine, the question of the influence of various methods of basic tillage on sugar beet productivity, yields of winter wheat and spring barley is solved ambiguously because of problems in their cultivation. However, we believe that in all zones in grain-beet rotation for sugar beets, it is advisable to implement an optimal fertilization system under the conditions of combination of organic and mineral fertilizers, which will provide a sufficient amount of nutrients needed by barley for growth. There is a lack of research data on the effect of fertilization of sugar beets, winter wheat and barley on beet productivity, yields of winter wheat, spring barley and sainfoin in the area of insufficient soil moisture.

Application of fertilizers is the most important means of enriching the soil with nutrients to satisfy the requirements of sugar beets in mineral elements [21]. It is above all necessary to apply fertilizers for sugar beets after nonfallow predecessors in farming rotation [4]. The high rate of complete mineral fertilization for sugar beets can be reduced by half, provided that 50 t/ha of manure is additionally applied [26]. It is recommended to apply 40–50 t/ha of manure under the conditions of deep ploughing directly for sugar beets or for previous winter grain crops [12].

Fertilizers also have a significant effect on sugar content of sugar beet roots. Regarding sugar content, there was a pattern: with an increase in the rate of mineral fertilizers sugar content decreases. Sugar accumulates better when phosphorus-potassium fertilizers are applied for sugar beets [13]. Under the conditions of applying high rates of mineral fertilizers, the quality of sugar beet often decreased. At the same time, not only sugar content in sugar beet tubers decreased, but also the yield during the processing of raw materials [2]. Above all, it is advisable to use fertilizers for wheat after worse predecessors. Under conditions of insufficient soil moisture, barley productivity depended on the aftereffects of an organic and mineral fertilization system of sugar beet, as well as on the characteristics of farming rotations. Application of mineral and organic fertilizers for sugar beets, winter wheat, and corn for silage in grain-beet rotations provides sufficient nutrition for peas, barley, perennial grasses in aftereffects [5, 6, 8, 9, 14]. It is advisable to apply fertilizers for wheat after worse predecessors.

Thus, yield of sugar beets depends on all elements of technology, the most important of which are fields after better predecessors, optimal level of farming rotation intensity taking into account soil and climatic conditions, application of economically justified fertilizers and introduction of environmental tillage methods [3, 5, 10, 15, 23]. Nowadays it should be more important not to achieve maximum sugar beet productivity by applying organic and mineral fertilizers for beets but to obtain maximum profit, rational resource use and to improve soil fertility by proper using fertilizers.

Conclusions.

1. The practice of ploughing to the depth of 30–32 cm for sugar beets and flat loosening at 20–22 cm for grains against the background of application of $N_{140}P_{90}K_{90}$ + straw for beets provided the highest productivity of sugar beets: the beet root yield and sugar collection were 39.9 t/ha and 6.83 t/ha, respectively.

2. The practice of ploughing to the depth of 20–22 cm for winter wheat against the fertilized background provided the significant increased yield of wheat grains by 0.21 and 0.45 t/ha, respectively, compared to flat soil loosening for the crops.

3. Against the background of application of fertilizers for sugar beets at a dose of 25 tons of manure + $N_{90}P_{90}K_{90}$ + straw + haulm in row crop rotation and in grain-row crop rotation, it was noticed the aftereffects on barley growing, which significantly increased the yield of barley by 0.22; 0.85 and 0.79 t/ha, respectively, compared to the background without fertilizers, without straw and without haulm.

4. In short-term crop rotation under the conditions of flat loosening to the depth of 20–22 cm for barley with intercropping of sainfoin the practice of application of 6.25 tons of manure + $N_{33,8}P_{33,8}K_{33,8}$ + straw + haulm in one cycle of rotation per 1 ha of arable land the highest productivity of sainfoin hay t 8.82 t/h was obtained.

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Анотація. *Уперше для умов Лівобережного Лісостепу України в тривалому стаціонарному досліді на чорноземі типовому слабкосолонцюватому встановлено вплив способів обробітку ґрунту на продуктивність цукрових буряків, урожайність озимої пшениці, ярого ячменю й еспарцету залежно від фонів їх удобрення в короткоротаційних сівозмінах. Польові дослідження проводили в стаціонарному досліді Веселоподільської дослідно-селекційної станції Інституту біоенергетичних культур і цукрових буряків Національної академії аграрних наук України упродовж 2015–2020 рр. Отримано найвищу продуктивність цукрових буряків у короткоротаційній плодозмінній сівозміні за проведення оранки на глибину 30–32 на фоні внесення* $N_{140}P_{90}K_{90}$ *+ солома: урожайність коренеплодів і збір цукру становили 39,9 т/га та 6,83 т/га відповідно. У результаті досліджень рекомендовано в польових сівозмінах використовувати комбіновану систему основного обробітку ґрунту, яка передбачає оранку під цукрові буряки на 30–32 см і поверхневий або мілкий обробіток під зернові та кормові культури.*

Ключові слова: *цукровий буряк, озима пшениця, ярий ячмінь, еспарцет, обробіток ґрунту, удобрення, сівозміна.*

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