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Comparative Analysis of Sugar Beet Cultivation Using Conventional Loosening and Strip Till Technology

Abstract

In the context of the intensification of agriculture, the choice of the optimal technology for growing sugar beet, which ensures an increase in yield and profitability of production, is particular relevance. In the Yevlakh region of Azerbaijan, where climatic conditions are characterized by dry periods and soil heterogeneity, it is important to conduct a comparative analysis of traditional and strip tillage technologies.

Traditional technology includes plowing, harrowing, and cultivation, which helps improve soil aeration and texture. However, this treatment system leads to moisture loss, destruction of the humus layer, and increased fuel and labor costs. In contrast, strip till allows you to cultivate only narrow strips of soil, preserving its natural structure and reducing erosion processes.

The analysis showed that the use of strip till technology helps to increase the moisture retention capacity of the soil, reduce resource consumption and increase plant resistance to drought. This makes this technology promising for implementation in the conditions of the Yevlakh district, ensuring the environmental and economic efficiency of sugar beet production.

Keywords: *sugar beet, strip till, traditional technology, yield, soil moisture, economic efficiency, Yevlakh district*

Introduction

Sugar beet is an important technical crop that requires optimal conditions for root crop formation. One of the main factors influencing the quantity and quality of the crop is the method of tillage. This article discusses two methods:

Conventional loosening (traditional processing)

Strip-till technology

Let's consider their effectiveness using the example of the Yevlakh region, Azerbaijan, taking into account soil and climatic conditions.

Soil and climatic conditions of the Yevlakh district.

The Yevlakh district is located in the Central part of Azerbaijan and is characterized by a moderately dry subtropical climate.

Soil types: gray-earth, meadow-gray-earth, and alluvial-meadow soils.

Average annual precipitation: 350-400 mm.

Precipitation during the sugar beet growing season (April–September): 150-180 mm.

The sum of active temperatures during the growing season (above +10°C): 3400-3600°C.

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Features of the region: hot and dry summers, which makes water conservation a critical factor in the cultivation of sugar beet.

Description of tillage methods

The usual loosening:

Research

It includes plowing to a depth of 20-30 cm, subsequent cultivation and harrowing.

The soil is completely turned over, which facilitates the development of the root system.

It allows effective weed control.

Strip till technology:

Strip loosening of soil 20-30 cm wide while maintaining untreated row spacing.

Combines tillage, fertilization and sometimes sowing in one pass.

It preserves plant residues on the field surface, reducing erosion and moisture evaporation.

Influence of cultivation methods on soil properties (under Yevlakh conditions).

Indicator	The usual loosening	Strip-till technology
Soil structure	Loosens quickly, but may be over-compacted below the plowing area	The structure of the top layer is preserved, and compaction is minimized
Moisture content	Rapid loss of moisture, especially in the upper layers	Reduction of moisture evaporation due to plant residues
Soil temperature	Quick warm-up in spring	Slower heating due to plant residues
Microbiological activity	Less organic matter, high mineralization	High biological activity, less erosion

Influence on the growth and development of sugar beet

Advantages of Conventional (traditional) loosening:

Rapid seed germination due to good soil contact.

There may be problems with over-compaction at a depth of 30-35 cm, which limits the development of the root crop (Doroshenko, 2018).

In Yevlakh conditions, during a dry summer, there is a risk of reduced yields due to moisture loss.

Advantages of Strip-till technology:

More uniform distribution of moisture.

Reduced risk of erosion and weathering.

Deep development of the root system due to the absence of a compacted layer.

Slow warming of the soil in spring can slow down the initial development, which is important to take into account in the conditions of the region.

Strip-till technology has been around for over 15 years. This technology is widespread in European countries, the United States of America, Canada and Azerbaijan. According to this technology, corn, soybeans, sugar beet, cotton, sunflower, potatoes, tomatoes, cabbage and many other vegetable crops are grown in the world. In Azerbaijan, crops such as corn, soybeans, and sugar beet are grown with this technology. To date, the greatest practical experience in using Strip-till (strip tillage) has been accumulated by American farmers, who were the first to see the high efficiency of this technology (FAO, 2022). For this reason, over the past 11-12 years, many farms in the so-called "corn belt" of the United States have switched to this technology, and about 17 companies in the country have organized the manufacture of equipment for Strip-till technology. Strip-till literally means "strip tillage". This technology occupies a place between classical (conventional) and zero tillage, that is, No-till. With strip tillage, the field is cultivated only in strips and sown with agricultural crops. Each row, plowed by devices for strip tillage, is about 20-25 cm wide (Gordeev, 2018). The rest of the area remains uncul-

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tivated, i.e. covered with stubble (remnants) of the previous crop. Strip-till is a system of economic use of nature, in which minimal tillage occurs. It combines the advantages of conventional tillage, such as drying the soil and warming it up. This type of processing is performed using special equipment - a Striptill cultivator. In addition to the described advantages of strip tillage, Strip-till has the advantage of conventional tillage in that an agronomist can apply chemical protection agents and mineral fertilizers simultaneously with tillage or sowing (Gumenyuk, 2017).

Due to global warming, the technology of strip tillage can be considered one of the most productive in the modern world. Since, according to the data of practical use, this technology is successfully successful both in drought and in high humidity conditions. When using this technology, only loosening of the strip in which the seeds of cultivated plants are sown is performed, and about two thirds of the field remains untreated. In this way, the soil retains its structure. With strip loosening, tillage consists of only two work operations, which are performed depending on the season (Ivanov, 2021):

Loosening in autumn or spring, then sowing in loosened strips. In Azerbaijan, the practice of using strip tillage shows that agricultural producers using Strip till technology have more opportunities to obtain high yields, as the crop is in optimal conditions during the growing season and becomes more resistant to adverse environmental conditions. Azerbaijani agronomists can save on fuel when preparing the soil for sowing, achieve lower labor costs and fertilizers. Also, save on the number of repairs and operation of the tractor, and reduce general household expenses. This is one of the most important conditions for a farmer, given the income from the harvest with the least labor and money (Kiryushin, 2015).

We can give an example of the use of band-pass technology in Russia. Practice shows that the technology has produced excellent results in the cultivation of row crops. Especially corn and sunflower seeds.

In Azerbaijan, the Azersugar farm operates in the Yevlakh region using this technology. In recent years, production experiments have been conducted on growing corn and sugar beet using Strip-till technology. The resulting yield turned out to be 30-40% higher than on the site using traditional technology. The farm also found that 240 kg of ammophos is sufficient for corn cultivation in the strip treatment system when applied in autumn, and 150 kg/ha for sugar beet (calculations were carried out at the request of the soil after the results of agrochemical soil analysis) (Konovalov, 2016). When using traditional technology and continuous fertilization, farms usually used twice the norm (450 and 300 kg/ha of ammonium). The average yield of corn for grain using No-till technology is 80 kg/ha, and on a Strip-till plot it is 100-120, and the yield for sugar beet is 600 and 900 kg/ha. In the near future, the farm plans to cultivate other crops using Strip-till technology (Klimov, 2019).

Traditional tillage.

This treatment includes several techniques depending on the time:

Main processing (winter plowing)

Spring processing

Pre-sowing treatment

In the system of agrotechnical measures that contribute to further increasing the yield of agricultural crops and improving its quality, winter plowing is of great importance. The soil that has been plowed since autumn is exposed to various degrees of climatic factors during the cold season, such as precipitation, wind, freezing and thawing. With this effect, the soil surface becomes finely lumpy. Chafing is especially effective in soils with a gley horizon. Also, timely winter plowing is a mandatory measure in the fight against clogging of fields, which provides favorable conditions for spring and pre-sowing preparation of arable land for sowing, obtaining friendly seedlings, good development and high yield with early ripening (Miller, 2020).

Finch plowing provides high efficiency if carried out at a favorable time, which is mainly in the period from October 25 to December 10-15, and in the southern regions it is possible later. If for some reason it was not possible to produce the winter plowing according to the specified dates, then this procedure can be postponed to the prudent days of January, February and March. At this time of the year, tillage will have the same effect than if you leave the tillage on the eve of sowing (Romanov, 2019).

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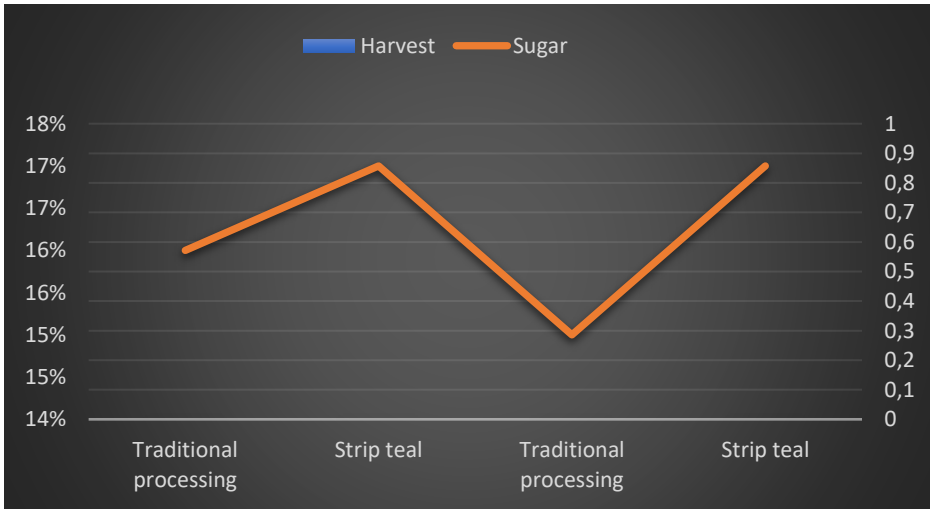
In our article, we want to show the effectiveness of these technologies in sugar beet cultivation. But it must be taken into account that sugar beet does not allow late tilling of the soil and it is impossible to perform deep plowing in the spring, taking into account also the conditions of the region. Therefore, it is necessary to limit ourselves to the exact time and execution of winter plowing in the autumn period. At the same time, 70% of the mineral doses of phosphorus and potassium should be applied during this period, calculated from 100% of the percentage for the entire growing season.

Spring processing for sugar beet involves closing moisture when the soil is physically ripe. This operation is performed by combined units in one pass. Such treatment ensures the creation of a loose lumpy soil structure with a content of at least 85% of lumps up to 10 mm in size in the loosened layer and a soil density of 1.0 – 1.3 g/cm3. Lump sizes of more than 30 mm should not be allowed (Smith, 2021).

Pre-sowing tillage is aimed at leveling the soil surface, preserving moisture in it that has accumulated in the autumn, winter, and spring periods, and destroying weeds that begin to germinate by this time. Pre-sowing treatment creates conditions for sowing seeds, sealing herbicides, fertilizers, which leads to the provision of friendly and full-fledged shoots of sugar beet.

For soils subject to wind or water erosion, a soil protection technology is recommended, which provides for non-destructive loosening of the soil to a depth of 20-22 cm, leaving mulch on the surface of the field (Zhou, 2020).

Sugar beet yield and product quality indicators (sugar content, %)



Indicator	The usual loosening	Strip-till technology
Average yield	45-55 t/ha	60-90 t/ha
Sugar content	15–16%	16–17%
Cost price	Higher due to the higher number of operations	Lower by reducing processing
Maturation dates	A little shorter	It can be elongated

Traditional loosening

Strip-till Technology

With traditional loosening, the following strategies should be followed: use deep freezers (destruction of the compacted layer), ensure timely irrigation to compensate for moisture loss (below 150-180 mm during the growing season), and use balanced fertilizers containing trace elements.

When Strip-till is processed, it is necessary to optimize the sowing time, use drip irrigation systems (in our experiment, sprinkling irrigation) to maintain uniform humidity, and apply fertilizers locally to the sowing strip.

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Conclusions

Strip-till technology shows the best results in yield and quality of sugar beet in the conditions of Yevlakh due to the preservation of moisture and soil structure.

Conventional loosening remains effective with good irrigation, but requires high costs.

In conditions of low precipitation and high active temperatures, strip-till technology ensures more sustainable and economically profitable sugar beet production.

Result:

For the Yevlakh region, Azerbaijan, strip till technology is promising solution that allows efficient use of available water resources and consistently high yields.

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