International periodic scientific journal
ONLINE
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Indexed in
INDEXCOPERNICUS
(ICV: 95.33)

MODERN ENGINEERING AND INNOVATIVE TECHNOLOGIES

Heutiges Ingenieurwesen und innovative Technologien

Issue №20
Part 3
April 2022

Published by:
Sergeieva&Co
Karlsruhe, Germany

ISSN 2567-5273
DOI 10.30890/2567-5273

The International Scientific Periodical Journal **"Modern Technology and Innovative Technologies"** has been published since 2017 and has gained considerable recognition among domestic and foreign researchers and scholars.
Periodicity of publication: Quarterly
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The journal is registered in IndexCopernicus, GoogleScholar.

UDC 08
LBC 94
DOI: 10.30890/2567-5273.2022-20-03

Published by:
Sergeieva&Co
Lußstr. 13
76227 Karlsruhe, Germany
e-mail: editor@moderntechno.de
site: www.moderntechno.de

http://www.moderntechno.de/index.php/meit/article/view/meit20-03-038
DOI: 10.30890/2567-5273.2022-20-03-038

UDK 631

ANALYSIS OF THE PRACTICE OF SOWING CORN ON SMALL FARMS

АНАЛІЗ ПРАКТИКИ СІВБИ КУКУРУДЗИ В НЕВЕЛИКИХ ФЕРМЕРСЬКИХ ГОСПОДАРСТВАХ

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Abstract. *Practical significance of the elements of technologies of sowing corn for grain is investigated in the article. It is revealed that a positive effect in the form of an increase in productivity and reduction of expenses as a result of application of modern sowing complexes of precision sowing of corn is possible when bringing all components of the sowing technology to perfection. Factors of soil preparation for sowing in order to preserve spring moisture in the soil, ensure soil leveling and prepare high-quality seedbed are analyzed. The importance of choosing sowing dates in order to obtain simultaneous germination of corn is emphasized. Possibilities of modern computerized sowing complexes as an element of precision sowing are clarifired.*

Keywords: *corn, precision sowing, soil, planter, Precision Planting, singulation, seedlings, quality, depth, density, method of sowing.*

Formulation of the problem.

In recent years, corn has been and remains a strategic crop for Ukraine, which is grown in almost all regions, regardless of climatic conditions and farm sizes. It is sometimes believed that corn is quite easy to grow and unpretentious, but in fact to get high and stable yields it still needs to be able to grow and constantly learn in the process. After all, conditions are changing, so are hybrids, new pests and diseases are emerging. So you always need to prepare for this in advance.

Corn is very demanding for quality soil preparation. Sowing is the mainspring event in the cultivation of corn. It completes all the preparatory work carried out in the autumn and spring. It is a multifactorial process with several successive technological operations.

The issue of determining the optimal sowing dates has been studied for a long time, but every year in the State Register of Plant Varieties Suitable for Distribution in Ukraine, new maize hybrids appear, which differ not only in precocity and a number of morphological features, but also respond differently to day length and quality, sunlight, humidity, air temperature, and other environmental conditions.

When determining the optimal sowing dates, it is necessary, first of all, to take into account the requirements of corn for germination conditions and the peculiarities of agro-ecological conditions of spring. Homeland corn in South America. This origin explains its need for sufficient heat for growth and development. Therefore, the study of corn sowing technology is of great importance.

Analysis of research and publications.

Research on the improvement of tillage in order to accumulate the maximum amount of moisture and its long-term retention in the area of development of the root system of crops is of scientific and practical importance. In the complex of agrotechnical measures of corn cultivation, on which the harvest and its quality

depend, sowing occupies an important place.

Questions about sowing corn are reflected in the works of agricultural scientists who have made a significant contribution to the study and use of different methods of tillage such as Ya. Bielov, L. Vozhehova, L. Voroniuk, K. Hribiniuk, M. Hrabovskyi, O. Dobrenkyi, A. Kovalenko, O. Muzyka, K. Popova, O. Tsyliuryk, Ya. Tsytsiura, and others.

But despite the significant scientific achievements of scientists to this day will remain uncertain a number of problems, the solution of which requires a study of the peculiarities of sowing technology.

Formulation of the goals of the article.

The purpose of the work is to substantiate the most optimal methods of pre-sowing tillage and sowing of corn and emphasize special attention to the need for careful compliance with agricultural requirements and quality control of work at all stages, which provides a significant increase in yield.

Presentation of the main research material.

Corn is a valuable agricultural crop of modern world agriculture. It is one of the most productive cereals, the grain of which is used in various branches of agriculture and industry. Among all cultivated plants grown in the world, corn, along with other cereals, occupies a leading position.

The best for corn are cultivated soils, which ensure uniform distribution of seeds during sowing and friendly germination, as well as ensure the penetration and development of the root system in the arable and subsoil layers. One part of the root system is located shallowly, forming a branched system, the other penetrates to a depth of 2 m or more, which increases the resistance of maize plants to lodging. Various kinds of over-compaction negatively affect the air-heat regime, inhibit the development of the root system and, as a consequence, leads to a decrease in the absorption of nutrients and moisture. Therefore, care should be taken to preserve and improve the soil structure during tillage. An important role is played by the prevention of compaction of the running systems of tractors, combines, etc. The structure of the soil in the fields set aside for corn should be improved by carrying out all the necessary agronomic measures in the process of basic and pre-sowing soil preparation [13]. It must provide:

- elimination of compaction in arable and subsoil horizons;
- homogeneous soil structure of optimal physical state;
- uniform distribution in the arable layer of crop residues;
- provocation to weed germination and control;
- preservation of soil moisture, absorption, and preservation of precipitation, prevention of water and air erosion;
- a sufficiently flat field surface for high-quality sowing.

The choice of methods of basic and pre-sowing tillage is closely related to the specific soil and climatic conditions of the area and the particle size characteristics of the soil. In most regions, maize yields are limited by a lack of soil moisture. In regions with insufficient rainfall during the growing season, one of the main tasks is to improve the moisture-absorbing and moisture-retaining properties of the soil. So, the whole set of tillage operations should be aimed at reducing the intensity of impact

on the soil (Table 1), from reducing the number of passes through the field to leaving crop residues thereby reducing the depth (mini-till) and strip-till tillage area. In addition, some farms use no-till, and they must take into account that organic residues, although they reflect a significant amount of sunlight, reducing the heating of the soil surface, its undamaged porous structure in the case of high temperatures (above 35°C) constantly provides great moisture loss to complete rupture of capillaries.

Table 1 – The level of tillage intensity

Climate	wet	moderate	dry
Soil moisture	wet	moderate	dry
Soil structure	unstructured		structural

Source: formed by [13]

Carefully crushed and evenly distributed on the surface of the field plant debris helps to reduce the evaporation of moisture from the soil and reduce its temperature, improve the structure. On heavy loamy soils, it is necessary to maintain the capillary flow of water from the lower deeper horizons. The main obstacles are the presence of a "plow sole" and poor soil structure. Important measures to solve these problems are deep loosening or deep furrowing of the main tillage, increasing the organic matter content (application of organic fertilizers, use of green manure, crop residues). At the same time, performing plowing, you need to follow the following parameters, depending on the terrain:

- uniformity of depth ± 10% (2-3 cm) on the width of the unit, because the uneven cultivation will affect the accumulation of moisture, the quality of subsequent plowing, and the development of the root system of plants;
- bouldering is not more than 15%, because boulders very often with a small amount of moisture and lack of soil freezing do not lose their structure until spring, which greatly complicates both cultivation and development of the root system of plants;
- ridge is not more than ± 10% (2-3 cm), because, due to blowing ridges on all sides and increasing the area of soil heating, it causes rapid drying of the upper part of a significant loss of moisture in the spring [13].

During all fieldwork, including tillage, the minimum parameters of tire pressure on the soil should be observed in order to avoid over-compaction. Keep in mind that light sandy soils can be more compacted than heavier ones. In addition, the installation of paired or wide tires, reduction or removal of ballast from the tractor will help to reduce the pressure on the ground. Tillage should be performed when the soil is at physical maturity (this is a certain range of soil moisture, during which it is well crushed during cultivation without much effort and does not stick to tillage tools). Cultivation of mature soil allows obtaining the best quality at the lowest energy consumption. In clay soils, physical maturity is in a fairly narrow range of humidity - 50-65% of total moisture content (TMC). In lighter (loamy and sandy) this interval is much wider - 40-70% of TMC. Well-structured soils with a high humus content have a wider range of optimal humidity for quality cultivation. This is also of great practical importance, as different soils mature differently. Thus, in the spring

sandy and loamy ripen 5-7 days earlier than loam, and 7-10 days earlier than clay. Spring tillage should be carried out in such a way as to minimize the mechanical impact on the soil, preserve the structure formed by freezing, affect only the area of seed wrapping (depth), and protect the soil from excessive compaction, drying, and spraying. The action of capillary forces, ie the presence of capillary moisture is stored in the settled winter soil, which creates the best conditions for seed germination and root system development. With each additional passage, the structure of the arable layer is destroyed, and the moisture evaporates [13].

At the same time, it is important to carry out early-spring shallow (up to 3-5 cm) loosening of the soil - closing the moisture. As a result, the capillaries on the soil surface are destroyed, which reduces its evaporation. In addition, it promotes better heating and activates the activity of microorganisms, provokes the germination of weed seeds, which are then easily destroyed by pre-sowing treatment. To close the moisture is the most effective use of harrows with plumes.

Harrowing is carried out as soon as the ridges dry out from plowing. Harrowing should be carried out for one or two days. Delay in the implementation of this agricultural measure leads to significant moisture loss and reduced yields.

In fact, harrowing is mulching without cover materials. This group of agricultural measures includes early-spring harrowing of frost, early-spring harrowing of winter and perennial grasses, cultivation of steam, layering between rows of row crops, destruction of soil crust after rains.

The effect is achieved by loosening the soil to a small depth in order to destroy the soil capillaries, which draw moisture from the lower horizons to the surface. That is, there is mulching of moist dry soil.

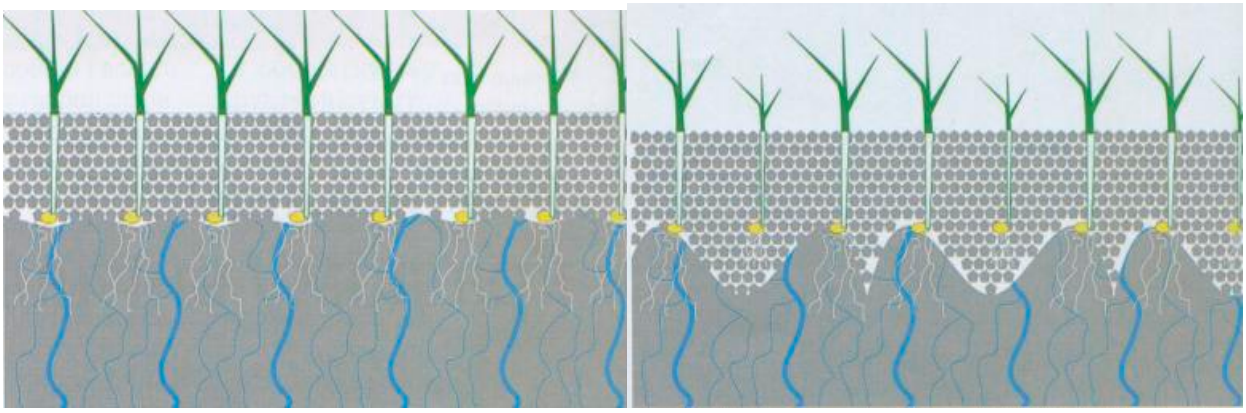
Early-spring harrowing of plowed, pruned, or loosened paw units allows achieving several agronomic advantages. First, it allows the primary leveling of the area. Secondly, to form a protective fine-grained layer on the surface of the field, which significantly slows down the evaporation of moisture. Third, destroy small weed sprouts in the white thread phase. An additional advantage of early-spring harrowing is a more uniform and partial grinding of semi-decomposed straw if it remains on the surface [11].

Early-spring harrowing does not require significant fuel costs, even with the use of wide-reaching units. It should be emphasized that in regions with a sufficient level of moisture for carrying out early-spring harrowing, toothed units are used, and in arid regions - needle units. The most efficient designs of such harrows include mesh-type units, in which each sector moves independently of the other. The ability to assemble hitches for early-spring harrowing of a significant working width provides exceptional productivity and does not require the use of heavy-duty tractors.

Equally important is the destruction of a spring soil crust, which sometimes leads to mass oppression and even the death of winter cereals in many regions of Ukraine. At the same time, the activation of microbiological processes in the soil and the improvement of moisture and air circulation are launched. According to quite realistic scientific and practical data, early-spring harrowing of winter allows increasing future yields by 10–20% [16].

Actually, pre-sowing tillage before sowing corn is loosening the soil to the

projected depth of seed placement. The most perfect tools for this operation are cultivators with arrow paws and combined units. It is not desirable to perform cultivation with chisel-shaped working bodies or even worse to prepare the soil with spherical disks. This leads to the formation of wavy seedlings and getting part of the seeds into dry soil (Fig. 1).



a) b)

Figure 1 – Corn germination after correct a) and incorrect b) pre-sowing tillage
Source: formed by [8]

Combined units for pre-sowing tillage in one pass provide leveling of the field surface, loosening it to a certain depth, crushing to a certain fraction in size, compaction, and preparation of the bed for sowing. The advantages of these tillage machines are replacement of 5-6 single-unit units; reduction of labor and fuel costs by 30%; reduction of terms of performance of works; preservation of moisture in the soil; creating a homogeneous density of the seed layer of the soil. In the designs of modern combined units for pre-sowing tillage such working bodies as an arrow paw on an S-shaped spring rack, rod rollers, toothed leveling knives is introduced, which allows improving the quality of work. Hard alloys are used to increase the wear resistance of the surfaces of the working bodies, which ensures their high reliability and durability [3].

Spring tillage should be performed only at the depth of sowing seeds. This will ensure the formation of a solid seedbed, the flow of capillary moisture to the seeds, its preservation in the soil, through the treated loose layer of soil will receive air and heat. The main mistakes during the spring soil preparation are:

- early start of technological operations on wet soil;
- a large number of passages (tracks);
- too high speed of units;
- large, greater than the depth of sowing, the depth of cultivation.

Thus, optimally prepared soil involves the formation of a loose mulched soil layer of 3-5 cm, compacted seedbed, and optimal density, without plow soles and compaction zones, with a good capillary structure of the root-containing soil horizon (from 40 to 150 cm). Under such conditions, the seeds will receive air and heat from above, and moisture from below [10].

The beginning and duration of sowing are some of the most important factors in obtaining high yields of corn. This measure determines the processes of growth and

development of plants, as well as the formation of their productivity.

Corn, as a heat-loving crop requires warming the soil to 10-15°C. In addition, the presence of moisture and the threat of late spring frosts are of great importance [14].

Crop damage is also affected by the magnitude of the decrease in temperature on the soil surface, and even more by the duration of cold weather at the beginning of germination. In 2020, in the Vinnytsia region, corn sown in the second decade of April was frozen three times: on May 8-9, 12-13, and 22-23. As a result, FAO > 320 maize hybrids did not tie cobs at all. And hybrids with FAO 280-300 sown in the late third decade of April gave an average harvest.

Delay of the beginning of sowing due to the threat of May frosts against the background of soil and air drought is possible with careful implementation of pre-sowing tillage measures to preserve moisture.

When the sowing period is delayed, the vegetation period is prolonged and there is a possibility that the plants may get into the first autumn frosts and have high grain moisture during harvesting (Fig. 2), which requires additional funds for drying the grain.

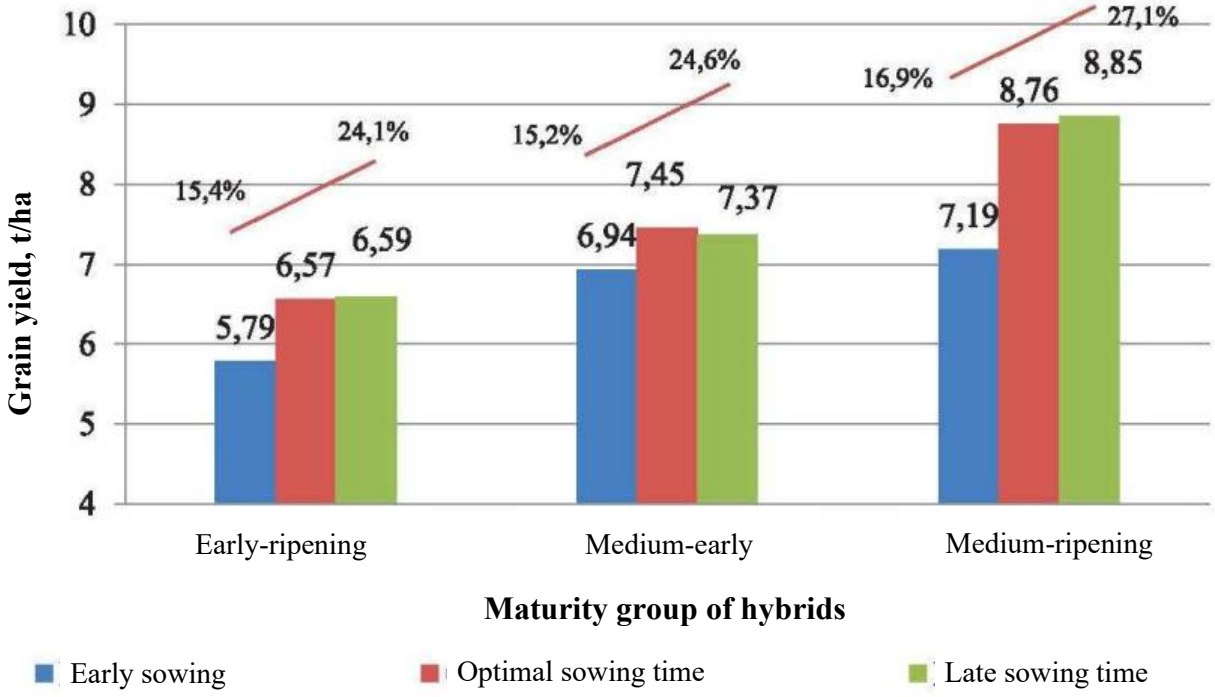


Figure 2 – Yield (t/ha) and grain moisture (%) of maize hybrids by maize ripeness groups

Source: formed by [7]

So, the high yield of corn grain with minimal energy consumption is formed during its sowing with constant warming of the soil, taking into account the biological characteristics of each hybrid.

The optimal depth for wrapping corn seeds is 5-7 cm, but always in a moist layer of soil. When it dries, the depth can be increased to 8-10 cm. It is important that the seeds that are sown are evenly distributed both in-depth and in a row. The constant depth of seed placement ensures friendly germination and uniform plant

development. In addition to the presence of moisture, the depth adjustment is influenced by the quality of field surface preparation and the perfection of the drill, its ability to withstand the specified parameters at a given speed. Failure to observe a depth of 1 cm can cause some seeds to settle in moist soil and some in dry soil.

The control of the depth of seed placement is carried out immediately after the passage of the drill to check the settings of the colters. This depth is not final, but it can be changed. The exact depth is determined after the emergence of seedlings, so setting up the drill requires some experience.

In modern technologies of corn cultivation, the important role belongs to the optimum density of standing of plants. It is this technique that determines the growing conditions of hybrids and affects the growth processes and development of plants. Plant density is one of the main factors that determine the effectiveness of the use of fertility, temperature, and water regimes of soil, solar energy, and other components of agrocenosis.

It should be borne in mind that hybrids of different precocity react differently to changes in plant density. Therefore, the yield capacity of hybrids of different maturity groups can be correctly established only at differentiated, according to the hybrid, the density of standing plants in relation to agro-ecological conditions.

The recommended density for the conditions of Ukraine varies between 40-80 thousand plants per 1 ha before harvest (Table 2). For early-maturing varieties and hybrids, plant density can increase to 85-90 thousand/ha and more [1].

The optimal density varies over the years and depends on both the biological characteristics of hybrids and the weather conditions of the second half of the growing season when there is a period of intensive water consumption of plants and often there is a recurrence of droughts. It is established that with increasing stem density of hybrids the total leaf surface area increases, which in turn affects the level of photosynthetic active radiation in crops.

Table 2 – Approximate density of plants of different precocious hybrids, thousand units/ha

Zone	Early-ripening	Medium-early	Medium-ripe	Medium-late and late-ripening
Central and Northern Forest-Steppe	60-80	55-75	45-65	-
Steppe	-	40-50	35-45	40-45
Western Forest-Steppe	75-85	65-75	55-70	-
Polissya	75-85	65-75	55-70	-
Transcarpathian lowland	-	70-75	65-70	55-60
Transnistrian zone (Chernivtsi and Ivano-Frankivsk regions)	60-70	60-65	55-60	50-55

Source: formed by [1]

In dense crops, less generative organs are formed, in the rudiments of future cobs and panicles the number of flowers decreases, which negatively affects the productivity of plants. In favorable years for moisture with increasing plant density increases plant growth in height and yield for hybrids of all maturity groups. The especially large increase in productivity is observed at transition from 40 to 60 thousand/ha. This is a general trend for most hybrids, but some of them tend to

thicken even more. Under adverse conditions, the rate of linear growth weakens, there is early death of the lower leaves and reduced yields. At the same time, liquefied crops are able to provide high individual productivity of plants, but due to insufficient density of stems per unit area, there is no increase in yield.

Along with changes in the indicators of individual productivity of plants under the influence of standing density, there is a transformation of signs of crop structure, and when the deviation of density from optimal to liquefied crops, increases, and with thickening - decrease. Thickening of crops to a certain level contributes to the accumulation of dry matter of aboveground mass per unit area, but the number of cobs decreases.

Crop thickening, in turn, is a provoking factor that increases plant lodging and cob drooping, which complicates combine harvesting and leads to crop losses [1].

The highest result is given by a field in which all plants are the same (came together, developed together, were in the same phases of development at the same time). In order to obtain such a result, it is necessary to divide all the possibilities of the field equally among the plants, to allocate each of its living space.

Today, the question of how to sow corn, in particular, narrow-row crops and twin-rows, the interest in which also increases with increasing sowing rate. In recent years, a number of studies have been conducted on this topic, which has shown different results, which suggests that many factors are likely to affect the reaction of the corn crop to the distance between rows.

The main rationale for narrow rows of corn is that by reducing the number of plants in a row, they can make better use of light, water, and nutrients, reducing competition between individual plants. Studies have shown that narrow-row sowing increased water uptake in the early stages of plant growth, which, with sufficient moisture at the end of the season, helped to increase yields. However, no significant benefits have been demonstrated under drought stress.

The main indicator of the drill can be called the uniform distribution of seeds in the field area. It is determined by the uniform supply of seeds in the furrow and the size of the row spacing. Feeding (dosing) of seeds in each row of the drill should be the same, which is estimated by the coefficients of uneven dosing and uneven sowing of seeds between rows. These coefficients should not exceed 3%, otherwise, the expected yield will be significantly reduced. To offset the effect of soil irregularities on the accuracy and depth of seed sowing, many manufacturers of this technique try to place the dispenser as close as possible to the ground, almost in the area of the support wheels of the sowing section of the drill. To ensure high sowing accuracy, it is also necessary to ensure the movement of the power tool at a certain speed, because the uniformity of laying at a certain depth and the same distance between the seeds directly depend on the speed of the drill during its operation. The next indicator of operation of units is the qualitative wrapping of seeds in a furrow. It is determined by the deviation of the seed from the specified depth. Thus, in the case of the depth of seed wrapping by 3-4 cm, the deviation of the occurrence should not exceed 0,5 cm, and 5-8 cm - up to 1,0 cm. The more uniform the seed will be wrapped in-depth, the farmer will get the best harvest. And if the opener creates the necessary conditions for the rapid germination of seeds, then we will get a friendly seedling. And for this

purpose it is necessary to place seeds in a furrow with a dense bed, that is to wrap sowing material in a furrow on the lower level, near its bottom, with the damp soil, with the subsequent consolidation of this soil.

It would not be an exaggeration to say that there are perhaps hundreds of models on the Ukrainian market of both universal row seeders and specialized corn and multifunctional sowing complexes. All this is mostly high-quality well-known equipment of domestic and foreign production, which is divided into units with mechanical and pneumatic dosing of seeds.

Accordingly, the dosing apparatus of the model can be mechanical or disk. The first option does not require airflow, so there is no need for seals and fans. Also, mechanical seeders are usually less exacting to the hydraulics of a tractor, and also to the purity and homogeneity of seeds.

Every year, mechanical units for sowing corn are gradually losing their former popularity. This is due to the fact that in such drills to adjust the row spacing and adjust the sewing machine to a certain caliber of grains need to change the entire working body. Since the seeds of the same maize hybrid can be of different sizes, it is necessary to readjust the sowing unit to the seeding rate each time a new batch of seed is loaded, which takes too much time and effort [15].

Pneumatic drills, on the other hand, are usually much more expensive and structurally complex. This automatically increases their operating costs and increases downtime risks. On the other hand, properly tuned pneumatic units save time and provide higher productivity and reduced costs.

Typical errors of the vacuum pneumatic sowing machine are duplicates and gaps (Fig. 3).

Figure 3 – Sowing machine errors - doubling and omissions

Source: author's proposal

Most modern models of drills are already equipped with sowing control systems in the base. If such a function is not available, it is quite easy to order and install.

One of the domestic manufacturers of sowing equipment is JSC ELVORTI. Ukrainian designers based the development of new models of row seed drills on the principles of precision seeding, namely improving the quality of seed distribution in a row. Precise sowing increases yields due to the optimal placement of plants in the feeding area and reduce the cost of forming their density.

JSC ELVORTI presents to farmers a wide choice of row seeders, namely seeders like Vesta, Vega, Vesta Profi, Vega Profi (Fig. 4). VEGA seed drills have a working width of 4,2 m, 5,6 and 11,2 m, or 6-row, 8-row, and 16-row, with a row spacing of 700 mm. Seeders with tractors from 80 to 180 hp are aggregated. On Vega Profi drills the electronic control system Helios is established, on Sesta Profi drills this function is carried out by the Sputnik system, on Vesta drills - the Fakt control system which control flight of seeds in each opener, its speed and transfer information to the monitor established in a tractor cabin, which allows you to keep track of sown area and seeding quality per square meter. The drills are equipped with a Profi sowing machine located on the frame, which, in turn, prevents the impact of loads on it and guarantees durability. The presence of upper and lower adjustable seed droppers ensures the absence of doubling during sowing.

Figure 4 – Corn seeder Vesta Profi

Source: formed by [9]

Research by research institutes and farmers' own experience show that accurate sowing can reduce production costs and increase yields, at least potentially. Every year more and more farmers start using precision drills, and, accordingly, sales of this equipment are growing.

When buying a new drill, the farmer can choose any precision sowing tools. Electric drives are able to change the norm on the go. The combined work of satellite navigation and maps of vegetation and yield makes it possible to maximize the return of highly productive areas due to resource savings on less productive. It is also guaranteed to save resources, which is provided by turning off the sections, and thus do not create areas with double the number of plants. This is actively used by tens of thousands of farmers around the world.

However, only the functions of precision drills became the standard. But their compatibility with different tractors is sometimes in question. And although the trailed equipment seems to be universal, the software of tractors does not always provide full-fledged "communication" with drills of other manufacturers - it is necessary to specify, buying this or that equipment.

Among the modern innovations should be mentioned adjustable row spacing and high working speed. That is, drills that can change the width of the rows and work two to three times faster than the old models, without loss of efficiency today are the very point of progress that should be focused on. Increasing the number of clamping force control systems, as well as many other sensor technologies are also included in the list of ways to improve sowing efficiency.

Good uniform seedlings are a characteristic that is usually called proof of the advantages of precision sowing technologies. However, today this is not enough. It is necessary to provide optimal conditions for the development of plants in areas of the field with different characteristics, and for this purpose, much more data should be taken into account.

Competent farmers and agro holdings experience all possible innovations that appear on the market: from variable standards and control of each line to more advanced technologies such as the SmartFirmer analyzer, which moves with the drill and collects current information about the main characteristics. Their experience shows that individual control of rows and hangs on the task map, which eliminate overlaps and take into account differences in different parts of the field, are more effective ways to reduce costs and get real savings before the harvest. The yield is a completely different story. It is difficult to assess the impact of sowing quality on this indicator, as there are other factors. However, manufacturers suggest comparative sowing with different drills with different accuracy within the same field and thus obtain information on the impact on yield parameters of sowing.

The new breath of precision seeding systems was given by the invention of the American farmer and his wife Greg and Cindy Sauder, the world has been using for more than 20 years. This is the Precision Planting seeding system. The first systems were imported to Ukraine in early 2008 on the basis of Kinze and John Deere seeders. Initially, farmers bought used American machinery, already equipped with Precision Planting. Subsequently, they began to purposefully bet on new models.

The complex of technologies and equipment Precision Planting is designed for a deep modernization of seeders in accordance with modern requirements of quality sowing. First of all, it is an ideal choice for those who use older drill models from CaseIH, AGCO, John Deere, Kinze, and Monosem. But more modern mechanical and vacuum precision seed drills also have significant potential for modernization

with Precision Planting in the areas [6]:

• increasing the accuracy of the layout (singulation) to 98 - 99%;
• introduction of automatic adjustment of seeding rate and clamping force;
• increasing the sowing rate.

Precision Planting is ideal for crops where high singularity significantly affects the level of yield: corn, sunflower, soybeans. There are also options for Precision Planting equipment for sowing rapeseed, sorghum, and other small-seeded crops, where their use can improve the quality of sowing [6].

On-board software for managing, collecting, processing and displaying information in real-time 20/20 SeedSense.

RowFlow - on-board "autopilot" of the drill with its own gyroscope and spatial orientation sensors, switch of separate control of sowing sections, designed for variable seeding rate, with details for each sowing section.

High-precision WaveVision high-precision radio wave sensors that do not react to dust and debris particles, clearly recording only the seed.

vSet seed drills with individual drive and separate pneumatic-vacuum system (for conversion of mechanical and vacuum drills), as well as previous generation sowing machines eSet (for vacuum drills) and Precision Meters (for mechanical drills). Provide an exceptionally high degree of seed singulation, up to the level of 98 - 99%, and almost complete elimination of the appearance of doubling [6].

Electric drive vDrive, for the sowing device vSet - provides individual control of each sowing machine, for the purpose of variable rationing of sowing on each section (row), their disconnection when working with overlapping on the area.

DeltaForce is a hydraulic system for controlling the clamping force of sections, which can automatically change the clamping force of each row.

SpeedTube seed tubes with a multi-section conveyor belt and the individual electric drive, for the guaranteed maintenance of high singulation of seeds at the increased speeds of work of the seeder, to 12 - 15 km/h.

CleanSweep - branded knife-disk cleaners of lines from crop residues, with individual hydraulic servo drives of control of pressing force.

Keeton Seed Firmer plastic shanks gently place seeds on the bottom of the seed groove and create optimal conditions for seed germination. In the latest versions, the Keeton Seed Firmer shanks are combined with the FurrowJet system for applying liquid fertilizers directly into the seed grooves next to the seeds.

SmartFirmer is a multifunctional soil condition sensor that monitors several parameters in real-time. It is able to determine the temperature, soil moisture, humus content, and the number of crop residues directly in the seedbed. The information provided by him becomes the basis for automatic amendments to the work of units and units that regulate the rate and depth of seeding, in the work of cleaners CleanSweep.

Precision Planting also has a solution for applying liquid fertilizers during sowing (FurrowJet, Conceal, vApplyHD) [6].

Systems of switching off of sections of drills, especially on field edges, along with control of norm of sowing and the remains of seeds in the bunker show very well. Thus, turning off the sections allows you to save up to 5% of seed by avoiding

reseeding on the turning lanes (Fig. 5).

Figure 5 – Corn reseeding on the turning lanes

Source: author's proposal

On the scale of sown areas, estimated at hundreds and thousands of hectares under a particular crop, such as corn, this provides a significant financial gain for agricultural owners.

Sowing corn or sunflower at a speed of 15-16 km/h is the prerogative of expensive sowing complexes of well-known manufacturers, which are serviced by qualified service engineers to experienced mechanics.

It is possible to sow at high speed, but not always and not everywhere. This is aerobatics in crop production, you need to work out to the smallest detail. Therefore, even if the farm has a suitable drill, it is necessary to increase the speed of sowing corn very carefully, remembering that the optimal rate is 8-9 km/h [4].

The application of liquid mineral fertilizers instead of granular ones during sowing is gaining popularity among Ukrainian agricultural producers. This technology is especially relevant, according to experts, in regions with a shortage of moisture, as well as in those farms where resource-saving agriculture is practiced.

The use of liquid mineral fertilizers as seed crops allows to obtain friendly seedlings, promotes the formation of a developed root system, and ultimately has a positive effect on increasing yields. The results are especially pronounced on row crops, especially on corn.

With the targeted application of seed, fertilizer increases the efficiency of its use. This is especially true of phosphates. Address farming has become widespread among those farmers who use resource-saving sowing technologies: without tillage or with minimal tillage - No-till and Strip-till [12].

In general, when working with such technologies there is a problem of applying fertilizers as such: if the soil is not prepared mechanically, how to apply fertilizers? The only option is to apply them immediately during sowing.

Liquid fertilizers applied as pre-sowing, first of all, need additional tight capacity. The liquid fertilizer hopper can be integrated directly into the main seed hopper or mounted on the seed drill. That is, in some cases it is an enlarged general hopper, which contains both seeds and granular "dry" mineral fertilizers and has a sealed compartment for liquids. However, in this case, the useful volume intended for seeds is reduced.

To avoid this, you can install an additional tank with liquid fertilizers.

However, when applying the full amount of fertilizer at sowing, keep in mind the high probability of reduced field germination. Especially at high doses, which will be necessary as yields increase. It is believed that the dose of fertilizer should not exceed 20 kg/ha d.v. for each battery. This is due to the fact that in direct contact (without a layer of soil) of fertilizers with seeds, a high concentration of the salt solution can adversely affect the germination of seeds [2].

When applying nitrogen fertilizers, such as urea-ammonia mixture as seed, there is a high probability of seed burns, especially at high doses. Therefore, the drill must be able to apply the urea-ammonia mixture separately from the seedbed. Structurally, this is not particularly difficult. A system of different wheels that earn seeds, "hedgehogs" installed with offset from the row, etc. can be used. That is, in fact, you can just put a side branch in the aisle. For example, in order to make liquid rows in between rows row seeders Great Plains YP3025A, YP4025A, YP2425A.

Phosphorus and potassium move very poorly from the application site, while the root system of the plant from the top layer of soil, which dries quickly, develops deep in search of moisture. Therefore, when applying liquid fertilizers it is better to lay them below the seedbed. For example, this is how all Bourgault grain drills equipped with the MRB system and the YP825A and YP1625AHL models from Great Plains work, which can lay the CAS at a depth of 3-10 cm on the side of the row.

Despite all the advantages, the pre-sowing application of liquid fertilizers is still very rare in both Europe and Ukraine. These are mostly single orders, but the tendency to increase them is already visible.

This is primarily due to the inconvenience of storage and logistics. If dry granular fertilizers are simply shipped in bags and stored in a regular warehouse without any problems, it is much more difficult to deliver the liquid and store it in the finished form: special tanks are needed, including for transporting LCDs to seeders. In addition, there will be a problem with storage at subzero temperatures. Therefore, it is desirable that the production of such fertilizers be located near the place of application.

Conclusions.

The task of obtaining timely and friendly germination of corn depends on many factors in choosing the method of basic and pre-sowing tillage, the choice of hybrid seed preparation, timing and duration of sowing, but the main thing is the choice of seeder and seed drill preparation.

Modern sowing complexes, which make it possible to realize the possibilities of precision farming, provide a potential opportunity to increase yields and reduce production costs. However, to obtain a high yield, the results of quality sowing by modern drills must be supported by all system elements of the technology of growing corn for grain. If any element is not performed at a high level, the results of quality work of an expensive sowing complex will be leveled.

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Анотація. *У статті досліджено практичне значення елементів технологій сівби кукурудзи на зерно. Виявлено, що позитивний ефект у вигляді збільшення врожайності і зменшення витрат в результаті застосування сучасних посівних комплексів точної сівби кукурудзи можливі при доведенні до досконалості всіх компонентів технології сівби. Проаналізовано чинники підготовки грунту до сівби з метою збереження весняних запасів вологи в грунті, вирівнювання грунту і підготовки якісного сім'яложа. Акцентовано важливість вибору строків початку сівби з метою отримання одночасних дружних сходів кукурудзи. Розкрито можливості сучасних комп'ютеризованих посівних комплексів, як елемента точного землеробства.*

Ключові слова: *кукурудза, точна сівба, грунт, сівалка,* P*recision Planting, сингуляція, сходи, якість, глибина, густота, спосіб посіву.*

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Indexed in
INDEXCOPERNICUS
high impact factor (ICV: 95.33)

Issue №20
Part 3
April 2022

Development of the original layout - Sergeieva&Co
Articles published in the author's edition

Signed: April 30, 2022

Sergeieva&Co
Lußstr. 13
76227 Karlsruhe
e-mail: editor@moderntechno.de
site: www.moderntechno.de

With the support of International research project SWorld
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ISSN 2567-5273