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**INNOVATIVE SOLUTIONS OF SECTION
PRESSURE AND INFLUENCE OF PRESSURE
CAPACITY ON AGRICULTURAL CULTURE
PLANTING**

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Osadchiy I.O. Innovative solutions for clamping section and effect of clamping capacity on sowing of agricultural crops

Abstract. *The relevance of the study is related to the determination of the effective mechanism of clamping the sections of the row drill. The purpose of the study was to analyze the available solutions for clamping the section and the impact of clamping capacity on crop sowing and its further development. First of all, the importance of uniform sowing was described for different types of crops, namely, sunflower, corn and soybeans. Further, the work describes the components of the section of the row drill, where its main elements are indicated. Further, the work reveals the topic of different types of pressure mechanisms of the seeder, namely: mechanical, pneumatic, hydraulic. Researching the last type revealed a number of advantages over its predecessors. The main advantages of hydraulic clamping are a quick response to changes in soil type using strain gauges and, with their help, soil density mapping.*

Key words: *seeding depth, clamping force, section, automaticity, mapping.*

Осадчий І.О. Інноваційні рішення притискання секції та вплив притискної здатності на посів сільськогосподарської культури

Анотація. *Актуальність дослідження пов'язана з визначенням ефективного механізму притискання секції просапної сівалки. Метою дослідження було проаналізувати наявні рішення притискання секції та вплив притискної здатності на посів культури та подальший її розвиток. В першу чергу було описано важливість рівномірного посіву для різних типів культур а саме, соняшника, кукурудзи та сої. Далі в роботі описані складові елементи секції просапної сівалки де вказані головні її елементи. Далі в роботі розкривається тема різних типів притискних механізмів сівалки а саме: механічний, пневматичний, гідравлічний. Досліджуючи останній типу було виявлено кількість переваг над попередниками. Основними перевагами гідравлічного притискання є швидка реакція на зміну типу ґрунту за допомогою тензодатчиків а, за їх допомогою, картування щільності ґрунту.*

Ключові слова: *глибина посіву, притискна сила, секція, автоматичність, картування.*

Introduction

Sowing is perhaps the most responsible stage in the entire complex of agricultural works [1]. It is at this time that you need to create the best conditions for the start of the plant with the most optimal ratio of moisture, access to oxygen and availability of heat [2]. After all, the law of the minimum states that the factor of the element that is in deficit determines

the quality indicator, and the element that is in excess will not be able to compensate for the insufficient amount of the previous one [3].

Uneven, too deep or shallow seed wrapping is the main reason for the decrease in field germination and the formation of low-yielding crops [4]. The optimal sowing depth of late spring crops (corn, sunflower, soybeans) is 4–5 cm, but depending on the zone of sufficient or insufficient moisture, it can vary within 1 cm [5]. Wrapping the seeds to the same depth makes it possible to get friendly and uniform seedlings, which ensures the constant development of plants during the growing season and contributes to more effective care of crops [6].

Analysis of recent researches

Homogeneity, in particular, reduces intraspecific competition between seedlings [7], reduces the germination of weeds [8], increases the area of nutrition and illumination of crops [9]. As a result, an increase in yield is ensured [10]. In addition, due to uniform ripening [11], there is no need for desiccation and post-harvest processing [12], which require additional costs [13].

If we are talking about the depth of sowing corn, then here the accuracy should be jewel-like [14]. After all, even minor fluctuations will provoke physiological deviations. A symptom of shallow seed wrapping (less than 3-4 cm) is an underdeveloped root system, which, for example, during a drought, will not be able to provide the plant with a sufficient amount of moisture [15]. Moreover, due to the lack of a reliable attachment to the soil, the so-called "no root syndrome" can develop, which will cause the plant to lie down, especially in dry soil in windy weather, and subsequently to its complete death [16].

And for soybeans, due to the epicotyl method of its germination, the sowing depth should not be more than 4 cm. After all, it is important for this culture to ensure uniform access to light: its lack provokes a decrease in nitrogen content, and this indicator is critical for growing soybeans [17]. On shaded plants, the number of incomplete beans increases, the height of their attachment to the stem becomes low, which complicates the process of harvesting with a combine harvester and, as a result, leads to a decrease in profit.

The aim and objectives of research

The purpose of the study was to analyze the available solutions for clamping the section and the influence of clamping capacity on crop sowing and its further development.

Research results

Only one that places the seeds not only at the same distance from each other, but also at the same depth of wrapping can be considered a high-quality precision seeding planter.

The planter is a whole structural organism in which all parts must work perfectly and perform their functions for the best possible sowing of grain in various conditions. The main mechanism in the planter is its section, which consists of certain elements (see Fig. 1).

Adequate seeding depth is one of the main factors of a successful seeding company. The correct setting of the pressure increase mechanism is crucial for the timing of sowing. Correctly selected pressure balance for adequate contact of the grain with the soil, without causing over-compaction, can dramatically affect the final result - the harvest.

The sowing depth is regulated by the depth wheels, which have different widths depending on the width of the row spacing. Three types of systems are used to maintain the seeding depth on precision seed drills: mechanical, pneumatic, and hydraulic.



Fig. 1. Section of the seeder of precision seeding: 1 – construction of the seeding device, 2 –
vas deferens, 3 – unfolds, 4 – turbodisc, 5 – opener, 6 – sowing depth adjustment system,
7 – seed sealer, 8 – rolling wheels

The mechanical clamping system is represented by springs installed on the parallelograms of the section (Fig. 2). The range of setting the pressure on the soil in this case ranges from 50 to 250 kg (Fig. 3).

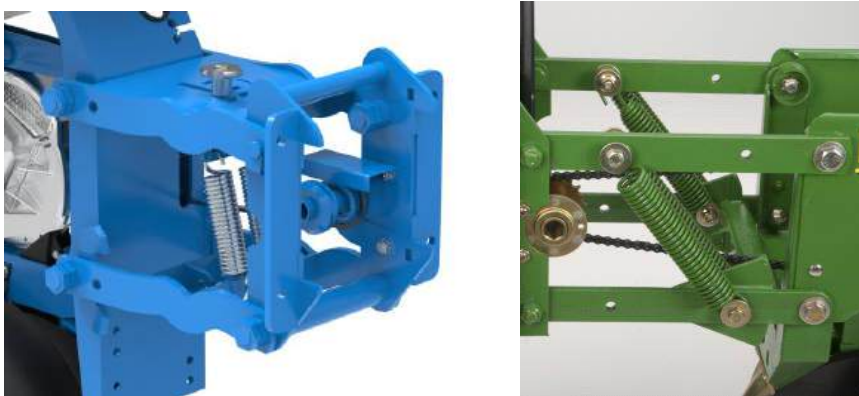


Fig. 2. Springs, with the help of which you can change the degree of pressure on the soil

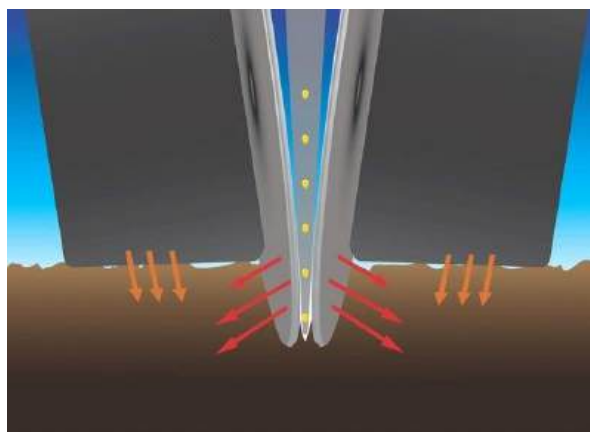


Fig. 3. Pressure on the soil

However, the mechanical system has one significant drawback - on a field with different types of soil (Fig. 4), there is no possibility to automatically adjust the pressure. So agronomists, to be 100% sure that the coulters will keep the depth evenly, adjust the springs to full force. Due to this, the parts work at their maximum and exhaust their resource faster.

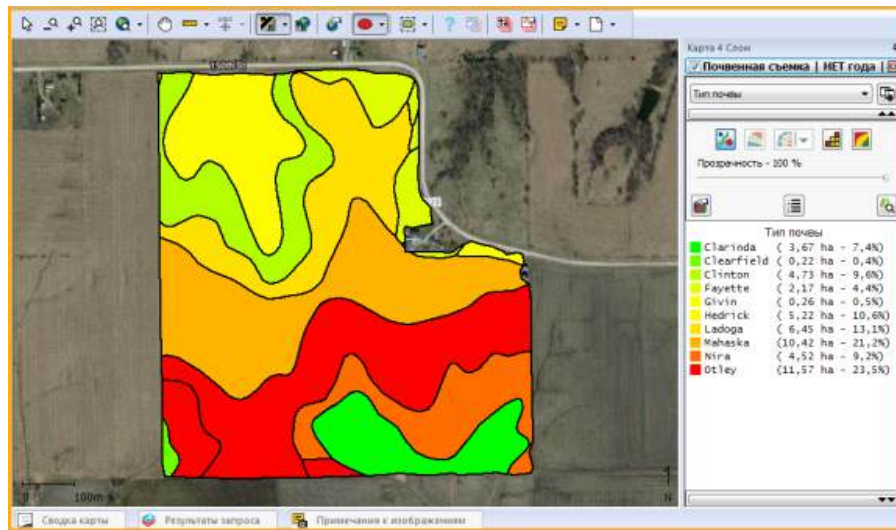


Fig. 4. Soil types in one field

If sowing is carried out on too soft soil, a large pressure of the springs is transmitted to the wheels of the depth and the coulters, which in turn leads to over-compaction of the seed bed and negatively affects the development of the root system in the first stages of plant development. Another disadvantage of springs is the loss of their elasticity, stretching, and because of this, failure to provide uniform pressure on all sections, which leads to uneven germination of seeds.

Meanwhile, air cushions evenly maintain the set pressure on all sections (Fig. 5). The pneumatic clamping system is used today in planters of many manufacturers (Kinze, John Deer, Gaspardo, etc.). It consists of the following elements: a control unit, a compressor, a receiver, pressure sensors, a pipeline, air cushions, and in some cases – a strain gauge.

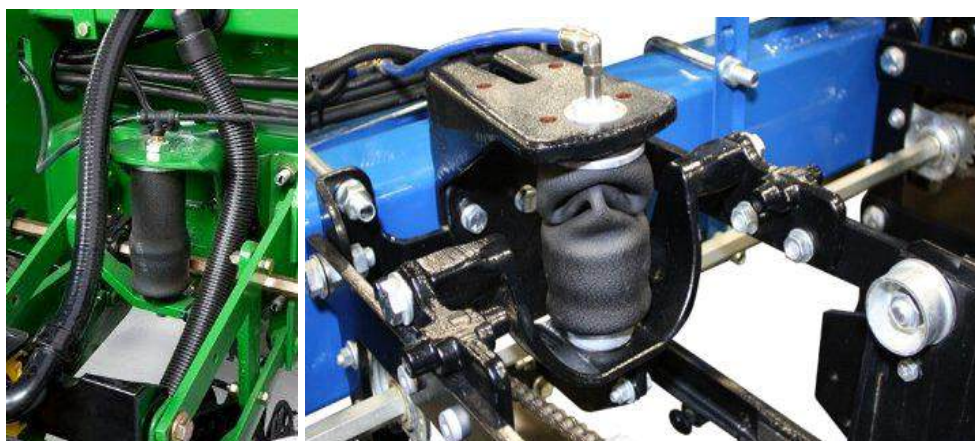


Fig. 5. Air cushions evenly distribute pressure across all sections

Clamping accuracy is about 80%. However, a serious drawback of the system is the parallel connection of pillows, the lack of ability to adjust the pressure separately on each section.

The speed of response to pressure changes in the system is high due to pumping air

from the receiver to the air cushions. During this period of time, the planter can move to harder soil, and it will be necessary to reduce the pressure (Fig. 6).

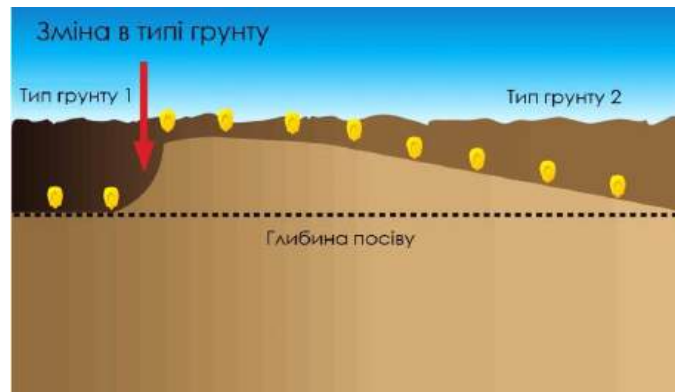


Fig. 6. Reaction to a change in soil type with pneumatic cushions

The hydraulic clamping mechanism with the help of double-action hydraulic cylinders can be safely called a precision farming system. Finding the optimal downforce is a challenge for manufacturers of precision farming equipment.



Fig. 7. Sure Force hydraulic clamping system from Ag leader

It should be emphasized that such types of mechanisms are complex and highly intelligent in design, but reliable and easy to operate. The system consists of such elements as a monitor, a set of cables, a main module, in-line modules, in-line valves, hydraulic cylinders, strain gauges

The hydraulic pressure system is an active pressure system that is installed on precision sowing machines. It works automatically, applying a clamping force when the load on the depth wheels is less than the specified one. When the pressure is more than enough to reach the set seeding depth, the hydraulic cylinder raises the section, preventing over-compaction of the seed bed. Strain gauges on each row sense changes in soil density and respond to them.

Some systems make it possible to see each planter row as a map on the display with the average load every second. The measurement frequency is 200 times per second (Fig. 8).



Fig. 8. InCommand 1200 AgLeader monitor.

Maps of fields after sowing or other operations, from field monitors, can be sent to a PC and processed in an agronomic GIS (geographic information system) program, or via a WI-FI network, transferred to an iPad and using applications provided by the equipment manufacturer, and viewed continuously in the field for analysis and making the necessary decisions.

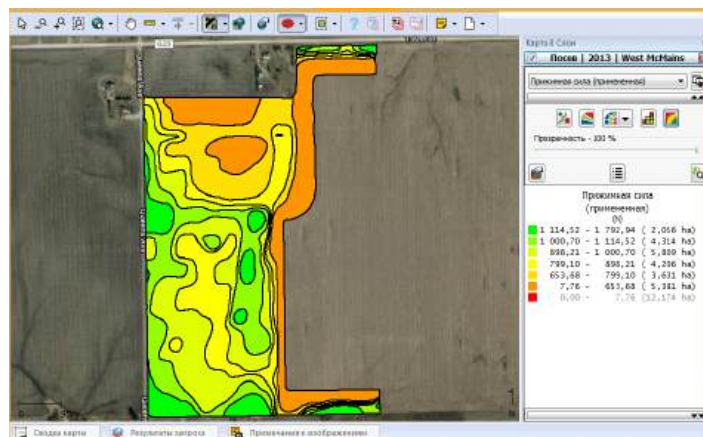


Fig. 8. Sure Force action during seeding in the SMS program.

Quickly and accurately adjust the pressing force, even in the areas of transition from soft sandy soil types to hard clay areas of the field – these are the possibilities provided by the system, giving the seed a chance to reveal its full potential (Fig. 9).

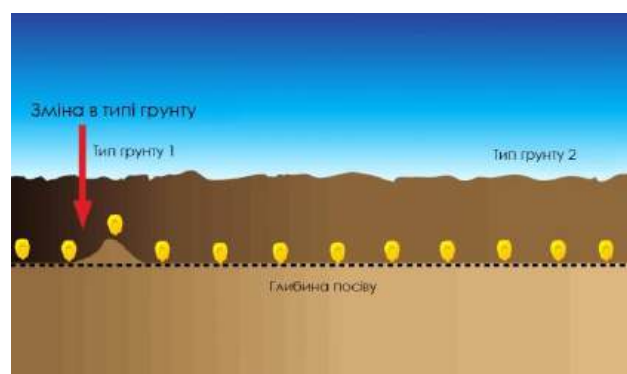


Fig. 9. Response to changes in soil type

Another Delta Force system from Precision Planting, which is installed on each section, also allows you to automatically change the planting depth (Fig. 10). As a result, each row can independently respond to changes in external factors, such as terrain or soil type.



Fig. 10. Precision Planting's Delta Force system



Fig. 11. Delta Force system with FieldView option

The Delta Force system consists of hydraulic cylinders and strain gauges to determine the applied force. Can be installed on most models of John Deere, Case IH and Kinze planters and some models of White and Monosem.

All data during seeding is transmitted to the 20/20 SeedSense monitor. But if you additionally use the FieldView option, you can view sowing maps with the downforce displayed on them. For example, on the left side of Figure 11, we can see how Delta Force "controls" the pressing force on each row for the optimal seeding depth (different colors indicate changes in the applied force). At the same time, on the right, you can assess the

quality of sowing: there are practically no blue areas where the contact of the planter with the ground was lost, and red areas with excess pressure.

Conclusions

In the complex of works on the cultivation of agricultural crops, high-quality sowing is the most important factor in laying a high harvest. It is the uniform depth of seed wrapping that ensures friendly sprouting of plants and the absence of variegation. It is the automated systems for changing the pressing force in planters that best take into account variations in the type of soil (in contrast to mechanical and pneumatic systems). By working with a dealer of reliable precision farming equipment, farmers can already set up equipment for sowing with the ideal depth and maximum consideration of the conditions in a particular field.

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