Evaluation of the quality of work of the selected seeder for soil protection technologies

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Abstract: *We focused on the assessment of the quality of work of the selected seeder used in soil protection technologies, with the aim of optimizing its efficiency and contributing to sustainable agriculture. Soil protection technologies, which are increasingly important in connection with soil degradation and changes in climate conditions, require precise and efficient agricultural tools. Seeders play a key role in seed application, and their performance directly affects soil quality and crop yields. We monitored the accuracy of sowing, uniformity of seed distribution, depth of their planting, as well as the impact of the seeder's work on soil structure and protection against erosion. The research results provide comprehensive information on the effectiveness of the seeder in terms of soil protection technologies, identify potential shortcomings in its performance and suggest possible improvements. These findings are relevant for agricultural practice, where a combination of high yields and soil protection is required, and contribute to the optimization of technological processes in modern agriculture.*

***Keywords**:* SOIL PROTECTION TECHNOLOGIES, SEEDER, SUBSOILER, EFFICIENCY OF AGRICULTURAL MACHINERY

1. Introduction

Agricultural production faces many challenges, including maintaining soil quality and its long-term productivity. The basic condition for achieving these goals is the introduction of effective and ecological agricultural technologies that support the protection of the soil environment [9]. Soil protection technologies, which focus on minimizing soil erosion, improving its structure and preserving its fertility, represent an important part of modern agriculture. One of the main tools used to implement soil protection technological procedures are seed drills [5]. The quality of their work has a direct impact on the efficiency of sowing, the growth and development of crops, as well as on the protection of the soil from degradation. It is therefore necessary to evaluate in detail how a particular seed drill meets the requirements that are placed on modern soil protection technologies [11].

We focused on evaluating the quality of work of the selected seeder intended for soil protection technologies at University farm Kolíňany. To obtain comprehensive data on its performance, accuracy and impact on soil structure, various aspects will be evaluated, including sowing uniformity, seed placement depth and their distribution in the soi [12]. The results of this research can provide valuable information for optimizing the technologies used and their application in practice. Based on the data obtained, the required technology will be designed to optimize its efficiency and contribute to the wider use of soil protection technologies in agricultural practice [3]. In this way, it is expected that the results of the work will contribute to the better use of agricultural machinery that is both soil-friendly and sustainable in terms of environmental protection

2. Materials and Methods

Seed quality is a key factor that significantly influences the success of agricultural production. The correct depth, spacing and placement of seeds contribute to optimal germination and plant growth, leading to higher yields. The negative consequences of poor seed quality, such as seed germination irregularities and competition between plants, can significantly reduce resource efficiency. Investments in technology and expert seeding practices thus pay off through increased yields and sustainability of agricultural activities [12].

The aim was to evaluate selected aspects of the quality of work of the Lemken Solitair seeder and the He – Va subsoiler with oilseed rape seeding at the University farm Kolíňany of the Slovak University of Agriculture in Nitra [7].

Based on the goals of the solution, we can also divide the methodological procedure into three parts:

- monitoring soil properties,
- monitoring the properties of the seeds used,
- monitoring the surface distribution of seeds in the soil in field conditions.

Methodology for monitoring soil properties
From the soil properties, we monitored:

- soil type,
- soil condition,
- soil structure,
- soil specific gravity,
- soil bulk density,
- soil porosity,
- soil moisture,
- soil penetrometric resistance

Regular monitoring of soil condition helps prevent soil degradation, reduces the risk of erosion and ensures sustainable development of ecosystems. In addition, a quality assessment of soil condition supports decision-making processes in the field of crop planting and implementation of appropriate fertilizers, thereby contributing to increasing yields and minimizing environmental impacts [2]. For this assessment, we used common methods of determining soil properties using Kopecký rollers with sampling after loosening and in rows after sowing at depths of 0-30 (15), 30-60 (45), 60-90 (75) with 3 - multiple repetitions [10].

We monitored the soil structure (Fig. 1) as a grouping of individual soil particles and aggregates by taking samples from a depth of 0-30 mm and processing them using a standard sieve method with a grading of soil fractions from < 0.125 mm; 0.125 - 0.63 etc. up to 8 - 16 mm; 16 - 32 mm and above 32 mm after pre-sowing soil loosening [4].

Fig.1 *Soil grain size monitoring device*

Seed properties monitoring methodology

In laboratory conditions, we monitored the dimensional and shape properties of seeds in accordance with the prescribed standards and regulations [1]. The shape properties of seeds significantly affect the quality of sowing, within the framework of the problem being solved, we monitored the properties of seeds that can affect the quality of sowing or germination. In laboratory conditions, the dimensional properties of seeds (WTS) were monitored in accordance with the valid standards STN 46 06 00, STN 46 06 09, STN 46 03 10 and the methodology for testing seeds and seedlings [8]. To determine the dimensional properties of seeds, we used a special device built at the Institute of Plant Protection and Biotechnology. This device (Fig. 2) consists of a specially modified micrometer, which allows us to determine all three dimensions of the seed.

Fig. 2 *Showing the method of determining the dimensional properties of seeds*

The connection to the tractor in the mounted version is carried out via a three-point hitch, which ensures stability and correct positioning of the device during operation. In the case of the semi-trailer version, the connection is possible either via the lower drawbar, which allows flexibility in manipulating the center of gravity, or via the lower hook, which ensures firm attachment and stability. For versions with a frame width of 4 meters and more, which is intended for transporting wider areas, the frame is designed as a split one. This design allows for easier transport while respecting the requirement for the maximum permitted width during transport [12].

Hydraulic folding provides flexibility in work. It allows the beam with the sowing feet to be folded either vertically (shown in Fig. 3 - B), which is ideal for precise adjustment of sowing in specific areas, or horizontally, in the direction of travel (shown in Fig. 3 - C), which allows efficient and smooth maneuvering in the field. In addition, there are hydraulically operated markers on both sides of the beam, which allow precise marking of rows during sowing, thus increasing the accuracy and efficiency of sowing. This system provides the operator with high comfort and efficiency in working in the field.

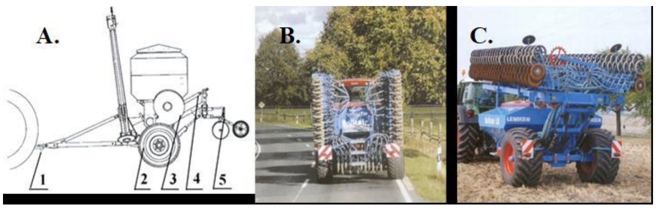

Figure 3 *A. trailed connection to the lower drawbar of the tractor: 1. lower drawbar, 2. single-axle chassis, 3. ventilator, 4. adjustment screw for adjusting the sowing depth, 5. parallelogram mounting of the sowing foot, B. folding the frame in the vertical plane, C. folding the frame in the horizontal plane*

The seeder uses a pneumatic sowing device with a volumetric metering unit. There are 4 volumetric metering units (or 2 x 4, depending on the width) located on the drive shaft (Fig. 3-C). These metering units are driven by an electric motor, which allows the shaft rotation frequency to be changed during travel, which makes it possible to regulate the seeding rate, or the number of seeds sown. The pulse counter wheel is used to measure the distance travelled. The Solitronic on-board computer calculates the processed area based on the number of pulses and the working width of the seeder.

3. Results

During the experimental measurements of soil properties that we carried out within the framework of soil protection technology, the following operations were performed. After harvesting the cereals, the condition was carried out with a disc tool with subsequent chemical destruction of emerging weeds and weeds. Subsequently, oilseed rape seeds were sown into the soil prepared in this way (Tab. 1).

Tab. 1 *Measured values of bulk density and humidity*

Wet sample weight	Dry sample weight	The difference between wet and dry	Bulk density of dry soil, t/m³	Humidity, %	Depth
200.82	181.11	19.71	1.753	10.67	0-3
204.32	183.3	21.2	1.878	13.54	3.6
218.53	192.3	26.23	1.973	17.65	6.9

Based on the obtained results (Fig. 4), we can conclude that the soil moisture was not affected by soil mixing during processing, or rather, the moisture distribution remained natural. As for the measured bulk densities, these were also carried out in individual depth variants.

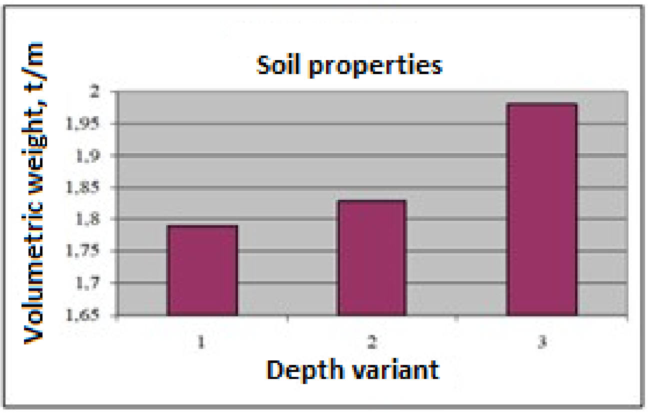

Fig. 4 *Volumetric density at individual measurement depths*

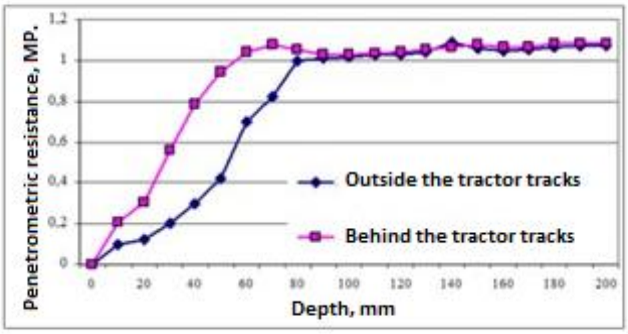

Fig. 5 *Results of penetrometric resistance evaluation in depth variants*

The penetrometric resistance (Fig. 5) curve gradually increases with increasing depth and reaches a maximum value of 1.1 MPa. Based on the obtained results, we can conclude that the seeding foot exerts a positive compressive effect on the soil bed. This factor should support the capillary action of moisture in the soil to the deposited seed.

One of the significant factors affecting the quality of sowing is the seed and its properties. The use of unsuitable seed often leads to its damage by the sowing device. Seed germination and its germination energy are equally important. We recorded the values of the relative multiplicity of dimensional properties with the value of length (Fig. 6), average scope (Fig. 7) and average size as the smallest dimension (Fig. 8). The dimensional properties of the seed are given by the largest dimension - length, the middle dimension - width and the smallest dimension - thickness and directly affect the quality of sowing. These measured dimensions affect the quality of filling the sowing roller. At the same time, the roughness of the seed surface, often affected by pickling agents, causes a different path of the seed during its guidance in the seminal ducts (especially over a longer distance), which disrupts the uniformity of sowing. Hybrid LG Amoroso with a minimum content of erucic acid and a satisfactory content of glucosinolates. Amoroso is a medium early hybrid. The plants are tall with medium resistance to lodging. The uniformity of ripening is good. The seed is large, the weight of a thousand seeds was 5.16 g. The oil content in the seed dry matter was high at 47.2% and the glucosinolate content was satisfactory at 16.9 micromoles/g of seed.

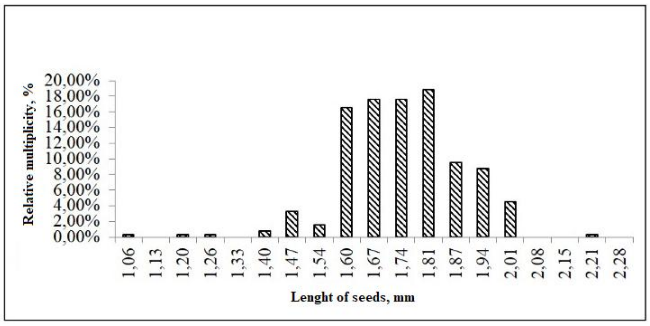

Fig. 6 *Relative multitude of seed length*

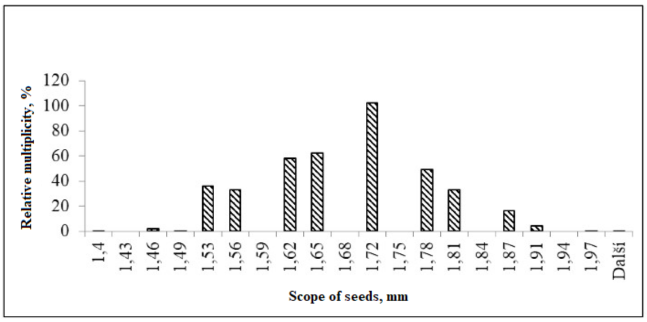

Fig. 7 *Relative multitude of seed scope*

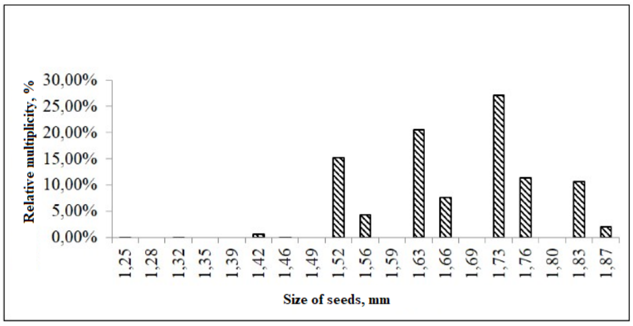

Fig. 8 *Relative multitude seed of size*

Results of the evaluation of yield-forming elements before harvest in a crop sown with Lemken Solitair and He-Va seed drills.

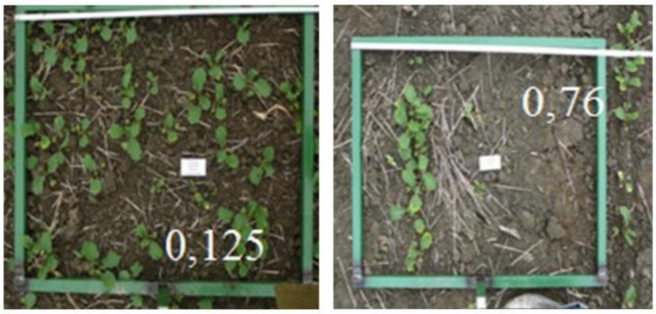

Fig. 9 *Photos from m^2 for individual sowing variants*

The measured values show that the average number of plants per 10m^2 is 187 with a row spacing of 0.125m and the average number of plants per 10m^2 is 115 with a row spacing of 0.76m (Fig. 9).

Tab. 2 *Overview of harvest results for winter rapeseed*

Sowing date	Harvest date	Yield, t/ha	Average number of branches per plant, pcs	Average length of rapeseed, cm
05.09.2024 He-Va	30.6.2025	2.68	19	122
03.09.2024 Lemken	30.6.2025	3.3	16	119

For the evaluation of yield-forming elements, we can state that better plant development was achieved with the sub-sowing machine with He-Va seeding, where the average plant height was 122 cm with 19 branches per plant, in contrast to the Lemken seeder, where it was only 16 branches at a plant height of 119 cm. Despite the above, we achieved a higher yield with the Lemken Solitair seeder with a value of 3.25 t/ha and with the He-Va machine it was 2.68 t/ha (Tab. 2).

4. Conclusion

The quality of the work of the He - Va subsoiler with rapeseed as part of the use of soil protection technologies was evaluated, specifically at the University farm Kolíňany SUA in Nitra. The work was mainly focused on the area distribution of seeds in the soil. The results showed that the correct setting of the seeder, especially in the area of sowing depth and evenness of seed distribution, significantly contributes to improving yields and reducing negative impacts on the soil. At the same time, it was confirmed that in the case of soil protection technologies, such as minimum tillage or no-till technology, it is important to take into account specific requirements for machine settings that allow effective work even with reduced disturbance of the soil structure, as was the case with the subsoiler. The quality of the work of the seeder in soil protection technologies is not only a question of technical perfection, but also the ability to correctly adapt the technique and work procedures to specific.

When comparing different types of seed drills, it turned out that some models provide better results in cases of work with high demands on sowing quality, as well as on maintaining soil stability. In conclusion, we can state that the quality work of the seed drill in soil protection technologies can contribute to sustainable agriculture, reduce the costs of soil preparation and support the protection of natural resources and protect the soil from water and wind erosion, which causes its excessive drying. For further research, it is necessary to continue experiments aimed at long-term monitoring of the impact of these technologies on soil, yields and production quality.

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