Effect of various methods of sowing on biomass production

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Abstract: *Oil-seed rape is a dominant oil plant in Slovakia. Recently the amount of its acreage has significantly increased. These days the oil-seed rape is mainly used in adipose industry. However the development of oilseed production also supports the development of environmental programs, which use rape seed to produce biodiesels and bio-lubricants. Nowadays the oil-seed rape produces about 40 % oil and 55 % extracted scraps and the effectiveness still increasing what makes the oil-seed rape a crop with various possibility of use . Oil-seed rape can be grown for green due to it grows rapidly and provides enough green mass. Very important factor for future crop production is the quality of seeding. Agronomic seeding date of oil-seed rape depends on production area (25.VIII – 31.VIII in corn and rape production areas, 20.VIII – 25.VIII in potato production areas, 10.VIII – 15.VIII in mountain production areas). The aim of this paper is to point to the possibilities for evaluating the quality of seeding of different drillers.*
Keywords: *oil-seed rape, quality of seeding, driller*

Introduction

Quality of sowing significantly affects the amount of future yield. This is especially true for sowing the small seeds of oil-seed rape (due to agronomic seeding date deadline and soil moisture). The germination and plant emergence is also affected by the other factors such as quality of soil tillage prior to sowing [5]. Tillage is particularly modifying the physical, biological and chemical properties of topsoil in such a way as to provide the above mentioned conditions [1]. To achieve the high plant emergence (min. 70 %) as the main assumption of sowing oil-seed rape and linseed is to create the optimal seedbed [7]. For the normal development of plants is necessary to provide for their nutrition a certain area, the size of which depends not only on the species, but also on the local conditions of its cultivation [4]. Fundamental agro-technical requirement is uniform distribution of seeds in the soil layer in the required quantity and under the conditions that the seed has not been damaged by sowing mechanism [6]. The term quality of spatial distribution of seeds in the soil we understand the horizontal (surface) and vertical (depth) distribution of seeds in the soil. It is clear that the deployment quality of seed in the soil has a direct effect on the germination, plant emergence, the use of space by crops, but also the use of appropriate machinery in the sowing, chemical treatment and harvesting crops [2]. Nearest to these requirements is the use of polygonal method. It uses the Delaunay´s triangulation and Voronoiov´s or Thiessen´s decomposition of polygons [3]. The above issues were addressed by other authors (Kuruc, 2013).

Material and methods

Research was conducted on the farm Agrodružstvo Rišňovce. Under these measurements we tried to compare the different methods of sowing by polygonal method. We tried to compare the sowing of drillers with intermittent and continuous seeding.

Method for the description of quality spatial distribution of seeds reflects the area per one seed (plant), taking into accounts the parameters of a longitudinal layout, row spacing and quantities of the seeds. Described polygonal method should allow comparing different methods of sowing by defining the individual mean area (living spaces) for each crop. Since the detection of distance between the seeds immediately after sowing is difficult we have performed this procedure after the emergence of the plants and their subsequent digitizing and image analysis (Figure 1).

The methodology of work can be divided into:

- monitoring of the seeds properties,
- monitoring of the soil properties,
- evaluation of the quality of sowing by shape factor and real area of polygons.

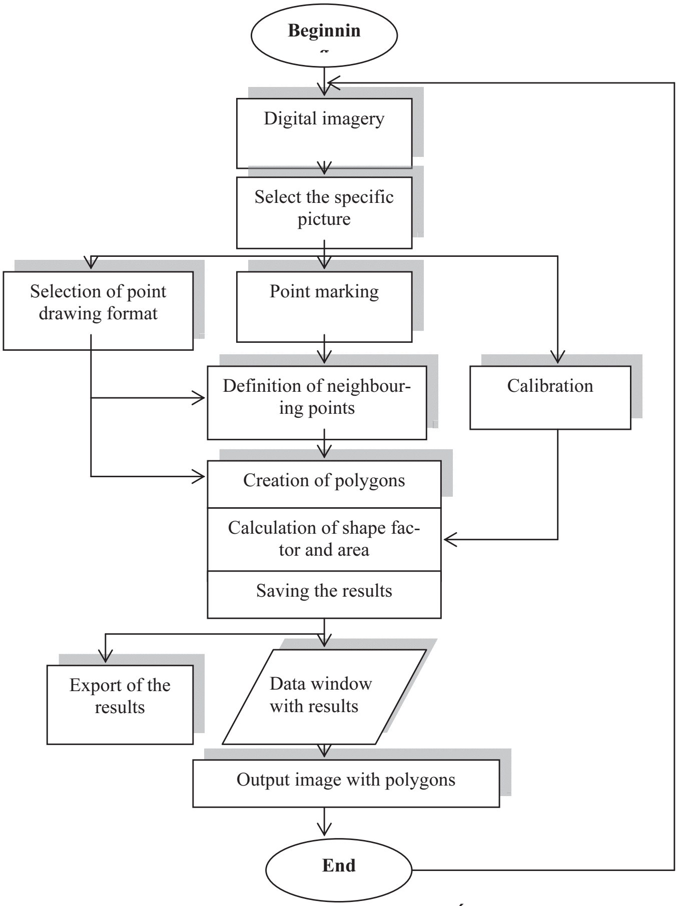

Figure 1. Data evaluation algorithm (MALÝ, MAGA, 2006).

Area per plant described by polygon is characterized by: area size, form (shape), plant position (eccentricity).

Size of the area per plant is of a great significance for the amount of the field germination and development of plants. Equal amounts of seeding result in the same average size of the area. It has been shown that the longitudinal distribution of seeds, row spacing and size of the area have an impact on the yield. Polygons with the same size of area can be distinguished in the shape of area corresponding to one plant. An ideal area should be a circle, but we are not able to reach that by currently used drills. Since the circle has the smallest area for a given perimeter, the ratio formed from ideal and the real circuit could be applied as a benchmark for describing the shape of the actual area deviations from the ideal measuring area (living space of plant). For evaluation of area shape were introduced so called form factor (equation 1).

$$\bar{T}_k = \frac{1}{n}\sum_{i=1}^{n}\frac{O_{ideal}.i}{O_{real}.i} \qquad (1)$$

where:

O_{ideal} – ideal perimeter of hexagonal polygon,

O_{real} – actual perimeter of measured polygon,

S_i – actual area of polygon.

Ideal perimeter will be then based on actual size of the polygon area as:

$$O_{ideal} = 3{,}7224\sqrt{S_i} \qquad (2)$$

The real area of a polygon (S_i) we get by the sum of the triangles areas which forms the polygon (Figure 2).

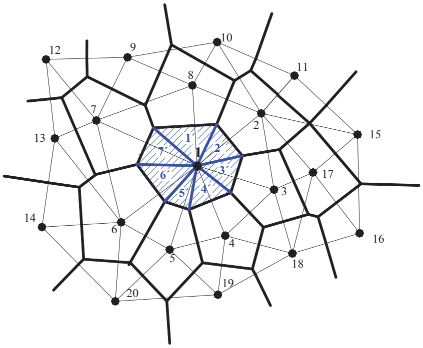

Figure 2. Polygonal distribution of points (plants): 1 to 20 - distribution of pints (plants); 1´to 7´- triangles forming a polygon created around the point 1

In addition to the size and shape of the area will have its importance also position of plants within the polygon (the eccentricity), however, compared to these characteristics is less significant and there are not developed a methods for its determination.

From the above knowledge we used in the evaluation of individual photos of oilseed crop, while we used the software TfPoly M, produced by doc. Dr. Ing. Juraj Maga. When using the referred software, firstly it is needed to adjust the photos into BMP format and trim them to the size of capturing frame. Subsequently, individual plants shall be marked out and selects the function: mark the neighbouring plants (Figure 3).

Consequently, it is necessary to select a polygon feature creation and export of results, where the evaluation indicators are already such as shape factor, actual area or the actual circumference of living area around the plant. All those elements of the evaluation gives an overview of the use of living area around the plant, its potential competitiveness in comparison with other plants and also allows to compare the different methods of sowing.

Figure 3. Detail of designation of neighbouring points and their interactions

Evaluation of spatial distribution of seeds has its justification in terms of future growth and development of plants. The area is more regular in shape of a circle thus more optimal is absorption of moisture, nutrients and sunlight.

Results

Measurements were carried out on loamy sand soils at the Agrodružstvo Rišňovce company. The research was requested by the practice, where the basic idea was if oilseed rape can be sown also by using of drills with intermittent seeding. For measurements, we used options of the company, where we compared the seed drill Amazone ED 309 with roller sowing mechanism seed drill Kverneland Monopill S – mechanical drill with the internal implementation of seeding holes. In the same conditions at different working speeds, different sowing rates, we focused on spatial distribution of seeds after sowing.

Table 1.

Results of the evaluation of soil properties in laboratory

RIŠŇOVCE				
weight of wet sample in g	**weight of dry sample in g**	**depth of measurement in mm**	**bulk density of dry soil t.m^{-3}**	**moisture, %**
146,79	122,28	15	1,22	20,04
129,42	105,51	30	1,05	22,66
125,76	101,41	45	1,01	24,01

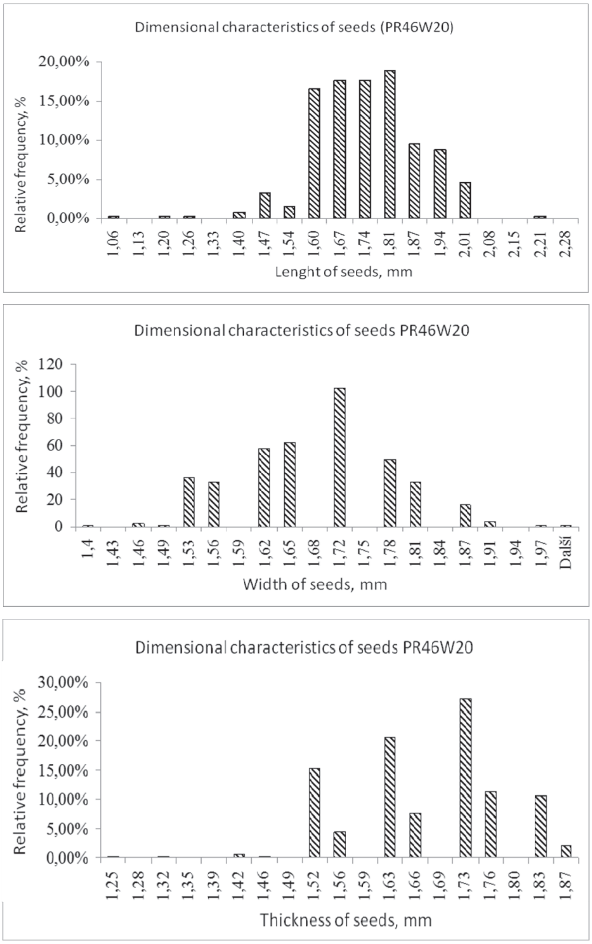

Figure 4. Dimensional characteristics of seeds (divided by length, width and thickness)

ISO 7256/1 and 7256/2 prescribe the characterization of conditions under which the measurements were conducted. It was a land with sloping 0-1°, BPEJ0145001, phosphorus 128 mg.kg^{-1}, potassium 145 mg.kg^{-1}, magnesium 159 mg.kg^{-1}, pH 7.3. After seedbed tillage we achieved the required finely crumbly texture (Table 1). Soil samples were collected by Kopecky rollers.

For measurements the seed PR46W20 were used produced by company of Pioneer. In terms of scoop process, it is important that seeds reached approximately spherical shape. The measured values of seeds dimensions were following: average length - 1.71 mm, average width 1.66 mm and the thickness as the smallest dimension - 1.65 mm. These values represent the basis of calculation of shape factors (k1 – 1.021, k2 – 1.006, k3 – 1.036, k4 – 1.030), where the smaller the difference between coefficients thus more spherical seed is.

We also tried to evaluate the penetrometric resistance through the digital penetrometer (Figure 5).

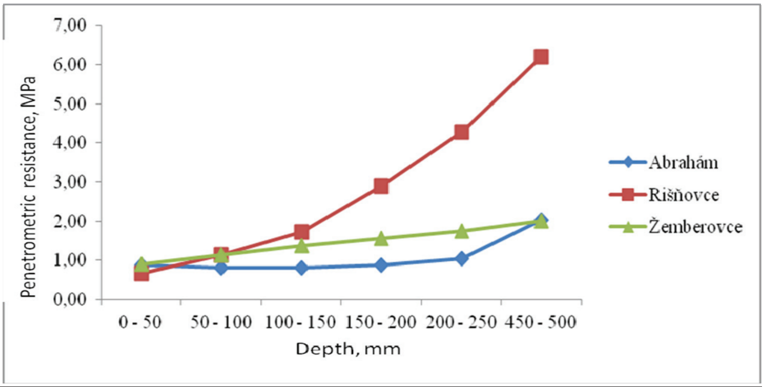

Figure 5. The course of penetrometric resistance measured at various sites (See the legend for various experimental sites)

Table 2.
A comparison of the evaluated parameters the different options used in Rišňovce.

	Rišňovce	
	Amazone 125 mm	**Monopill 450 mm**
Calculated ideal distance, cm	25	13,87
Seed rate per hectar	160 000	160 000
Yield of grains, t	2,4	2,9
Average shape factor	0,8	0,58
Average number of stems, n	3,49	10,45
Average number of siliques, n	66,46	215,91
Average height of plants, cm	110,07	107,22

When measuring the horizontal storage of seeds in the soil, we proceeded in accordance with ISO standard 7256/2, which, although does not prescribe the area measuring layout of seeds but tells about drills in terms of assessing longitudinal deployment of seeds during the sowing. What are the working conditions under which the object of research is trying to tell is about minimum operating speed up to the maximum operating speed in grading by 0.5 ms^{-1}. We were trying in measurements to observed of speed prescribed by the standard but some have adjust their energy resource options used in other standards prescribes the test machine on level ground and on a slope. For our measurement we used the land with sloping up to 2°.

Table 3.

Values of shape factor (Tf), specific surface area (S), row spacing 0.125 m a seed driller AMAZONE working at different speeds

Amazone ED 309	Working speed (km.h^{-1})		
	6,2	8	8,7
0,125 m			
Shape factor - Tf	0,909333	0,737997278	0,825057
Actual perimeter (mm)	299,4957	361,2366324	325,9506
Average area of a polygons - S (mm^2)	5902,247	5655,659	5755,219

Based on measured and evaluated data it can be concluded that the seed drill Amazone ED 300 with swing chisel plough with row spacing 0.125 m has its best working speed 6.2 km h^{-1}. It must be said that the evaluation criterion of regularity polygon is shape factor. The ideal shape for the development of the plant is a circle which has the value 1. Therefore, the closer the value obtained through the measurement thus the more ideal sowing in terms of shape.

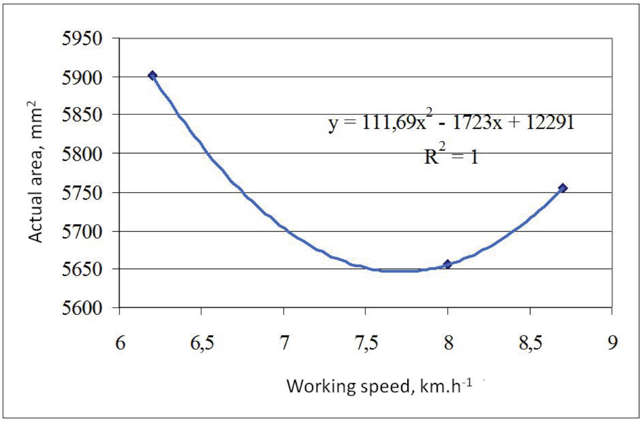

Figure 6. The dependence of the actual plants area on working speed of the machine Amazone ED

It is a value that is identical, although the value of drill Amazone but in terms of driller Monopill S at all speeds was reached relatively high values of shape factor. From the obtained values, we can see that as the best globally based on 0.450 m distance where the value of shape factor is 0.886 in comparison with row spacing where reached a value of only 0.823. The benefit of drill Monopill S however, tells also saving of seed which is achieved in comparison with conventional AMAZONE ED.

Conclusions

Quality and precision sowing to maximize germination and plant emergence is an important factor in terms of minimizing inputs into the production process, but also in terms of maximizing yields, and hence the total valuation of work for all seasons. Already in our country are considering seeding of oilseed rape by drills with intermittent seeding. Finding the optimal number of individuals and ideal inter-row spacing between plants is among the main objectives. Manufacturers of seed breeding new hybrids to deploy stems shallow over the soil surface and also offer new opportunities in growing this important crop. Based on these results we can conclude that from the perspective of shape of plant living space and hence in terms of method of sowing better results were achieved with driller with intermittent sowing Monopill S. The most appropriate row spacing distance was 0.450 m and especially at lower working speeds.

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Acknowledgement:

The Paper was supported by the project: Development of International Cooperation for the Purpose of the Transfer and Implementation of Research and Development in Educational Programs conducted by the Operational Program: Education, ITMS code: 26110230085

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Докладът е рецензиран.