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# INFLUENCE OF SELECTED FACTORS ON IRREGULARITY OF SPRING BARLEY SEEDS DOSAGE USING THE PRESS DRILL SEEDER

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K e y w o r d s: press drill seeder, barley, seeds, dosage regularity.

A b s t r a c t

The influence of sowing speed, intercrop width and width of seeds feeding slot width on irregularity of "Poldek" cultivar spring barley seeding with press drill seeder at 170 kg/ha was determined. As a result of factors correlation analysis at the assumed significance level of $\alpha = 0.05$ it was shown that the intercrop width and sowing speed were the factors that had a significant influence on seeds dosage. As a result of multiple variables regression analysis with step procedure for elimination of insignificant variables a quadratic equation was obtained.

## WPŁYW WYBRANYCH CZYNNIKÓW NA NIERÓWNOMIERNOŚĆ DOZOWANIA NASION JĘCZMIENIA JAREGO WYBRANYM KOŁECZKOWYM ZESPOŁEM WYSIEWAJĄCYM

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S ł o w a k l u c z o w e: kołeczkowy zespół wysiewający, jęczmień, nasiona, równomierność dozowania.

S t r e s z c z e n i e

Określono wpływ prędkości siewu, szerokości międzyrzędzi i szerokości szczeliny wysiewającej na nierównomierność dozowania kołeczkowym zespołem wysiewającym nasion jęczmienia jarego odmiany Poldek, wysiewanych w ilości 170 kg/ha. W wyniku analizy korelacji

czynników, przy założonym poziomie istotności $\alpha = 0.05$, wykazano, że spośród badanych czynników istotny wpływ na nierównomierność dozowania nasion mają szerokość międzyrzędzi i prędkość siewu. Z analizy regresji wielu zmiennych z krokową procedurą eliminacji zmiennych nieistotnych otrzymano równanie drugiego stopnia.

## Introduction and objective of study

All seeders, including universal ones, should place seeds in the soil in a way assuring their optimum development conditions during both the germination stage and the following development stages. That means that the seeds should be distributed not only at appropriate and uniform depth but also spread evenly over the entire area of the field (Kogut 2003, 2004, Rawa, Markowski 2005, 2006). Designers aim at high universality of the seeders and high quality of sowing independent of the operational conditions.

Irregularity of seeding, beside the structural working elements of the seeder/drill (seeding unit, duct and drill opener) and the physical characteristics of the seeds sown (geometry, humidity, shape and type of seed cover) can be influenced by factors such as seeding speed and intercrops width.

The study aimed at determining the influence of selected factors – drill operational speed, intercrop width and seeds feeding slot width on dosage irregularity of "Poldek" cultivar spring barley seeding with press drill seeder at the recommended seeds quantity of 170 kg/ha.

## Subject and methodology of study

The experiment was carried out at the laboratory test station consisting of two basic sub-units: the dosing unit – single seeding unit equipped with a standard press drill unit by PIMR (Fig. 1) and seed box – and seed position-recording unit (sticky, no end tape with the measurement section two meters in length ten centimeters in width). Both units were equipped with drives. The drilling unit in which all setups present in a standard universal drill seeder were retained was driven through a belt drive from the electric motor with adjustable rotation speed controlled by Siemens "Micromaster 420" frequency converter. The recording tape was driven by an electric motor supplied and controlled by "Inverton GMI S13" frequency converter.

The test material consisted of "Poldek" cultivar spring barley seeds with the mass of 1000 seeds at 55.35 g and humidity of ca. 9.5%.

The following factors were considered in the experiments:

Fixed factors:

– sown quantity 170 kg/ha,
– feeding slot width 35 mm.

Variable factors:

– drilling slot width 1÷5 mm, increment step 1 mm,
– drill seeder operational speed 4÷12 km/h, increment step 2 km/h,
– intercrop width 7÷15 cm, increment step 2 cm.

Resulting factor:

– seeds dosage irregularity $\delta$.

Before the proper experiment the capacity characteristics of the examined drilling unit was determined and next the rotation speeds of drilling shaft assuring constant unit placement of seeds in the field consequential to the assumed seeds drilling dosage (170 kg/ha) for the assumed values of variable factors were determined.

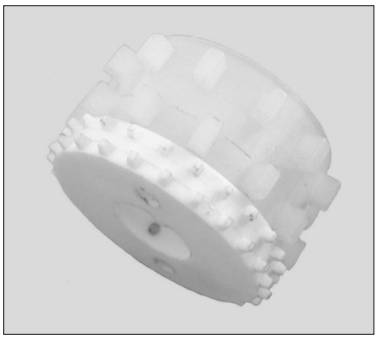

Fig. 1. Drilling shaft, design by PIMR in Poznań

The proper experiment related to determination of the irregularity factor for seeds dosage was conducted in three repetitions. The irregularity of seeds dosage was determined according to the guidelines of Polish Standard PN-84/R-55050. Seeds, after cleaning the working space of the drilling unit positioned centrally over the sticky tape at the distance of 20 cm (distance measured between the lower edge of the drilling unit walls and the tape surface) fell freely on the sticky surface of the tape from the height of 100 mm (distance measured between tape surface and edge of the bottom). The reading of coordinates for the seeds sown was done over the measurement section of the tape 2 m in length with the accuracy of 1 mm. After reading the ordinates of seeds positions the tape was cleaned from seeds and covered with a thin film of lubricant. Additionally, before conducting another repetition the level of seeds in the seeds box was restored.

The results of the experiment were processed applying mathematical statistics methods taking into account the correlation of factors, variance analysis in individual classification and regression analysis of many variables with stepped procedure for elimination of insignificant variables from polynomial to the quadratic equation.

## Results

Tables 1 and 2 present the capacity of the drilling unit and rotation speed of the drilling shaft assuring drilling of seeds at the dosage of 170 kg/ha.

Table 1

Capacity of drilling unit for the seeding dose 170 kg/ha

| Intercrop width $m$ (mm) | Capacity of drilling unit $Q$ (g/min) | | | | |
|---|---|---|---|---|---|
| | drilling speed $V_t$ (sticky tape) (km/h) | | | | |
| | 4 | 6 | 8 | 10 | 12 |
| 0.07 | 77.5 | 116.2 | 155.0 | 193.7 | 232.5 |
| 0.09 | 99.6 | 149.4 | 199.3 | 249.1 | 298.9 |
| 0.11 | 121.8 | 182.7 | 243.5 | 304.4 | 365.3 |
| 0.13 | 143.9 | 215.9 | 287.8 | 359.8 | 431.7 |
| 0.15 | 166.1 | 249.1 | 332.1 | 415.1 | 498.2 |

Table 2

Rotation speed of the drilling shaft for the seeds drilling dose 170 kg/ha

| Width of seeds feeding slot $S_r$ (mm) | Intercrop width $m$ (m) | Rotation speed of the shaft $n_w$ (rev/min) | | | | |
|---|---|---|---|---|---|---|
| | | sticky tape speed $V_t$ (km/h) | | | | |
| | | 4 | 6 | 8 | 10 | 12 |
| 1 | 0.07 | 3.7 | 5.6 | 7.5 | 9.4 | 11.3 |
| | 0.09 | 4.8 | 7.2 | 9.7 | 12.1 | 14.6 |
| | 0.11 | 5.9 | 8.9 | 11.8 | 14.8 | 17.8 |
| | 0.13 | 7.0 | 10.5 | 14.0 | 17.5 | 21.1 |
| | 0.15 | 8.1 | 12.1 | 16.2 | 20.2 | 24.3 |
| 2 | 0.07 | 3.6 | 5.4 | 7.3 | 9.1 | 10.9 |
| | 0.09 | 4.7 | 7.0 | 9.4 | 11.7 | 14.1 |
| | 0.11 | 5.7 | 8.6 | 11.5 | 14.3 | 17.2 |
| | 0.13 | 6.7 | 10.1 | 13.5 | 17.0 | 20.4 |
| | 0.15 | 7.8 | 11.7 | 15.6 | 19.6 | 23.5 |
| 3 | 0.07 | 3.4 | 5.2 | 6.9 | 8.7 | 10.5 |
| | 0.09 | 4.4 | 6.7 | 9.0 | 11.2 | 13.5 |
| | 0.11 | 5.4 | 8.2 | 11.0 | 13.8 | 16.5 |
| | 0.13 | 6.4 | 9.7 | 13.0 | 16.3 | 19.6 |
| | 0.15 | 7.4 | 11.2 | 15.0 | 18.8 | 22.6 |
| 4 | 0.07 | 3.1 | 4.8 | 6.5 | 8.2 | 9.9 |
| | 0.09 | 4.1 | 6.3 | 8.5 | 10.7 | 12.9 |
| | 0.11 | 5.0 | 7.7 | 10.4 | 13.1 | 15.8 |
| | 0.13 | 6.0 | 9.2 | 12.4 | 15.5 | 18.7 |
| | 0.15 | 7.0 | 10.7 | 14.3 | 18.0 | 21.7 |
| 5 | 0.07 | 2.6 | 4.3 | 5.9 | 7.6 | 9.2 |
| | 0.09 | 3.6 | 5.7 | 7.8 | 10.0 | 12.1 |
| | 0.11 | 4.5 | 7.1 | 9.7 | 12.3 | 14.9 |
| | 0.13 | 5.5 | 8.5 | 11.6 | 14.7 | 17.8 |
| | 0.15 | 6.4 | 10.0 | 13.5 | 17.1 | 20.6 |

Analysis of correlation between the assumed factors (tab. 3) shows that at the significant level of $\alpha = 0.05$ the width of intercrops with the correlation coefficient –0.66 and speed of the sticky tape (operational speed of the drilling seeder) with the correlation coefficient –0.23 had the largest and significant influence on the value of irregularity coefficient of "Poldek" cultivar spring barley seeding with press drill seeder The influence of working slot of the drilling unit on irregularity of seeds dosage is insignificant (correlation coefficient 0.013 is lower than the critical value of 0.101).

After multiple variables regression analysis with step procedure for elimination of insignificant variables a quadratic equation was obtained (tab. 3), the graphic representation of which is presented in figure 2. The graph indicates that seeds dosage uniformity increases with the intercrop width and drilling speed increase.

Table 3

Correlation matrix, variance analysis table and regression equation

| General information | | | | |
|---|---|---|---|---|
| Number of variables | 4 | | | |
| Number of observations | 375 | | | |
| Feature | | average | standard deviation | variability index (%) |
| Drilling speed $V_t$ (km/h) | | 8.00 | 2.83 | 35.40 |
| Intercrop width $m$ (m) | | 0.11 | 0.03 | 25.75 |
| Working slot width $S_r$ (mm) | | 3.00 | 1.42 | 47.20 |
| Seeds dosage irregularity indicator $\delta$ (–) | | 0.56 | 0.13 | 23.36 |
| Correlation matrix | | | | |
| | 1 | 2 | 3 | 4 |
| 1 | 1.0000 | 0.0000 | 0.0000 | -0.2229 |
| 2 | 0.0000 | 1.0000 | -0.0000 | -0.6616 |
| 3 | 0.0000 | -0.0000 | 1.0000 | 0.0135 |
| 4 | -0.2229 | -0.6616 | 0.0135 | 1.0000 |
| Verification of the hypothesis on significance of correlation coefficients | | | | |
| Assumed significance level | | | $\alpha = 0.0500$ | |
| Correlation coefficient critical value | | | 0.1013 | |
| $F$ statistics value | | | $F = 94.4625$ | |
| Probability of exceeding the calculated $F$ statistics value | | | $p(F) = 0.0000$ | |
| Standard deviation of residues | | | 0.0923 | |
| Regression equation | | | | |
| $\delta = -0.0256 \cdot V_t - 8.5731 \cdot m + 20.017 \cdot m^2 + 0.1395 \cdot V_t \cdot m + 1.3266$ | | | | |

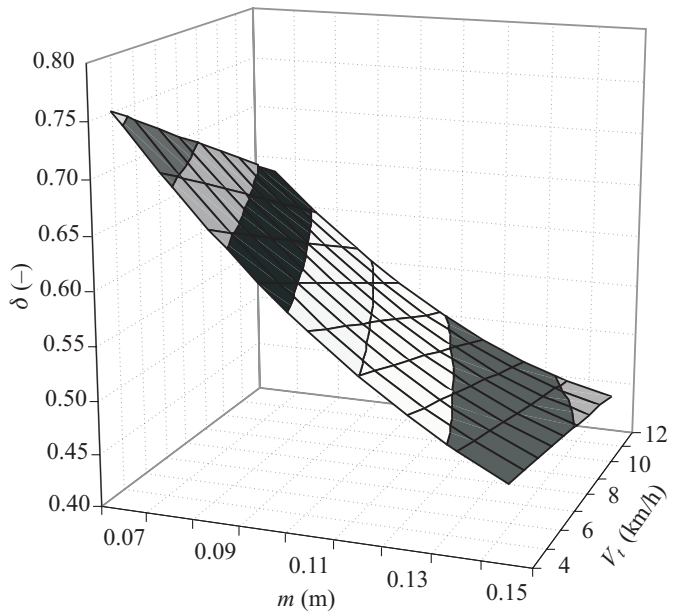


Fig. 2. Seeds dosage irregularity d as function of tape (drilling) speed $V_t$ and intercrop width $m$

## Conclusions

1. The drill unit operational speed within from 4 to 12 km/ha and intercrop width from 7 to 15 cm had significant influence on the irregularity of spring barley seeds dosage with the pressure drill unit at the dose of 170 kg/ha. The influence of working slot width of 1-5 mm is insignificant.

2. The irregularity of spring barley seeds dosage with the pressure drill unit can be described by a quadratic equation in which drill operational speed and intercrop width are the independent variables.

3. Maintaining the constant dose of spring barley sowing at 170 kg/ha, dosage uniformity with pressure drill seeder increases with the increased intercrop width and the operational speed of the drill (related to the dosing speed of the drilling shaft).

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