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EFFECT OF PRE-SOWING ELECTRIC TREATMENTS OF SEEDS ON THE YIELDS OF WHEAT VARIETIES ENOLA AND KRISTY

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Abstract

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Field tests were carried out after performed pre-sowing electric (electromagnetic and electrostatic) treatment of wheat seeds of the varieties Enola and Kristy. It was confirmed that the used helical device for pre-sowing electromagnetic treatment could contribute to an environmentally friendly and energy efficient increase of yields of the wheat varieties Enola and Kristy.

Variety dependence was established of both wheat varieties to the pre-sowing electric treatment of their seeds, the controllable factors being the voltage between the electrodes and the duration of treatment. At certain voltage levels, for both types of electric treatment – electromagnetic and electrostatic - a decrease in the yield of the studied varieties was recorded within the range of (1-5)%. Under different levels of the controllable impact factors, after the electromagnetic and electrostatic pre-sowing treatment a possibility was achieved to increase the grain yield of the wheat variety Enola within the range of (105.7-579.7) $kg.ha^{-1}$, and of the variety Kristy – within the range of (172.9-226.4) $kg.ha^{-1}$. The studies of the pre-sowing electric treatment of wheat seeds were carried out in the period (2010-2012).

Key words: pre-sowing electric treatment, wheat seeds, yield

Abbreviations: DAI – Dobrudzha Agricultural Institute, EM – electromagnetic treatment,
ES – electrostatic treatment

Introduction

The rapidly growing world population raises serious issues about with its feeding with quality products.

The long years of research carried out at ▫Angel Kanchev▫ University of Ruse jointly with other scientific institutes in Bulgaria and in Hungary show that with certain parameters of the pre-sowing electric (incl. electromagnetic and electrostatic) treatment it is possible to increase the yields of agricultural crops. In this respect, certain success has been achieved in maize growing (Palov et al, 2013), wheat (Palov et al., 2010; Sirakov et al, 2007; Palov et al, 2009), sunflower (Romhany et al., 2012), cotton (Stoilova et al., 2011), vegetable crops (Palov et al., 2012), etc. It has been theoretically proven (Palov et al., 2004) that after pre-sowing electric treatment the electric potential of the seed germs increases. This has a stimulating effect on the growth of the future plants.

The purpose of this study is to determine in field conditions the results of the pre-sowing electric (electromagnetic и electrostatic) treatment of wheat seeds.

Materials and Methods

For the purposes of this study, wheat seeds of the varieties Enola and Kristy were used. They have been developed in Dobrudzha Agricultural Institute - General Toshevo. The Enola variety is widely used in Bulgaria. Through the economic year 2013, the largest share of 39% (MAF, Agrostatistics, 2013) of the annual wheat production in the country has been formed by the Enola variety. Since 2001, this wheat variety has been included in the varieties list of the Republic of Macedonia.

The morphological characteristics of the wheat variety Enola include (Dochev et al, 2009): early maturing short-stem variety, resistant to lodging and very suitable for an in-

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tensive cultivation technology. Its biological features include good cold tolerance and winter resistance. The variety is tolerant to drought. It has very good resistance to diseases: powdery mildew, brown, black and yellow rust. The grain is classified as medium to high quality wheat. It is suitable for all types of bread and pastries. The variety is highly productive, with yields reaching as high as 9000 kg.ha^{-1}.

The morphological characteristics of the wheat variety Kristy are similar (Dochev, 2012; Pavlova and Dochev, 2010) to those of the variety Enola. Kristy is a mid-early variety, its stem height reaches up to 95-105 cm. Flexible, with a yield potential of 10 000 kg.ha^{-1}, classified as medium quality wheat.

It had been previously established that the helical device, a modified screw conveyor (Terziev et al., 1995), could be successfully used for pre-sowing electromagnetic treatment of wheat seeds (Palov et al., 2010; Sirakov et al., 2007; Palov et al., 2009).

Part of the tested seeds was subjected to pre-sowing treatment in an electromagnetic field created between the electrodes (screw and housing) of the helical device (Terziev et al., 1995). This field resulted from the supply of an increased alternating electric voltage to the electrodes – up to several thousand volts, for example (1…3) 10^3 V, i.e. (1…3) kV. In this case, the different duration of treatment of the seeds was adjusted by altering the rotational speed of the helical device.

Another part of the seeds were subjected to treatment between two electrodes – two parallel metal plates. Increased direct electric voltage was supplied to them. In this way an electrostatic field was created (Kuzmanov et al., 1996).

The plan of the experiment, according to which the pre-sowing treatment of wheat seeds was performed, is shown in Table 1.

The seeds were treated on 7 October 2010 and were sowed on 30 October 2010, i.e. they rested for 23 days after the pre-sowing treatment.

The experiment was carried out in the experimental field (Figure 1) of DAI - General Toshevo in 2010/11.

Fig. 1. Experimental field under wheat (DAI - General Toshevo)

Table 1
Plan of the experiment with pre-sowing electric treatment of wheat seeds during the years 2010/2011 (duration of treatment τ=10s)

Helical device fullness level			
50%		5%	
Pre-sowing EM treatment of wheat seeds of the variety Enola			
Type of treatment	Voltage U, kV	Type of treatment	Voltage U, kV
1	1.00	4	1.00
2	1.65	5	1.65
3	3.00	6	3.00
Pre-sowing ES treatment of wheat seeds of the variety Enola			
7	Voltage U=11.0 kV		
8	Voltage U=7.5 kV		
9	Reference specimen, untreated seeds of the variety Enola		
Pre-sowing EM and ES treatment of wheat seeds of the variety Kristy			
10	EM Treatment, with device full at 5%, U=1 kV		
11	EM Treatment, with device full at 50%, U=1 kV		
12	ES Treatment, U=8.5 kV		
13	Reference specimen, untreated seeds of the variety Kristy		

The seeds of each treatment option were sowed in six replications, and the reference untreated seeds – in 3x6 replications.

Each experimental plot had a reporting area of 15 m^2. The crop prior to wheat was pea grain. The crops were fed with 70 $kg.ha^{-1}$ active substance N on 14 March 2011 and were treated with Hussar Max herbicide on 24 April 2011. In the autumn, during the last but one pre-sowing treatment, 50 $kg.ha^{-1}$ of active substance P_2O_5 were introduced.

Results and Discussion

In accordance with Table 1, it was agreed that the results of the different treatment options would be compared with the reference ones – for wheat variety Enola this was treatment option No.9, while for Kristy it was No.13.

In graphic form, the results of a study of the average yield expressed as a percentage of the reference specimen (% /rs) of the wheat variety Enola are shown in Figure 2. The average yield of the reference specimen (option No. 9 - Table 1) from one experimental plot of 15 m^2 was 9.33 kg (i.e. 6220 $kg.ha^{-1}$).

In Figure 2 it can be seen that after the performed treatment of the seeds with duration τ=10 s and the helical device full at 50%, only for the 3EM option, at U=3 kV voltage between the electrodes of the helical device, the yield was 1.70% higher than that of the reference specimen. This means 105.7 $kg.ha^{-1}$ more grain was added to the yield.

The obtained results for the yield from options 1EM and 2EM were respectively: 99.14 %/rs and 97.86 %/rs. Therefore, for the large quantity of seeds (i.e. when the helical device was 50% full) during the treatment, the comparatively low levels of voltage applied (1 kV and 1.65 kV) between the electrodes of the device (Terziev et al., 1995) were not sufficient to impart enough energy to the seeds.

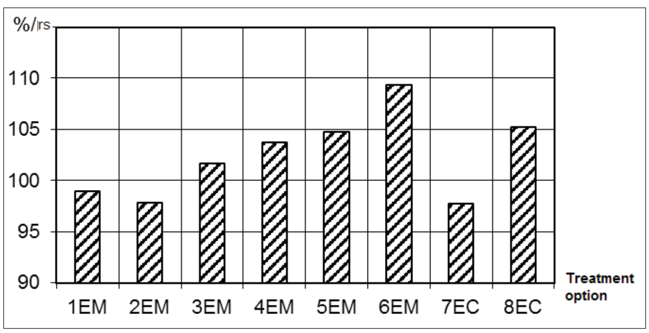

Fig. 2. Results of the study of the average yield (as a percentage of the reference specimen, % rs) of the wheat variety Enola in 2010/2011

Legend: (1EM…3EM) – pre-sowing electromagnetic treatment with the device full at 50%;
(4EM…6EM) - pre-sowing electromagnetic treatment with the device full at 5%;
(7ES и 8ES) – electrostatic pre-sowing treatment

All options of electromagnetic treatment of the seeds in the helical device full at 5% produced higher yields in comparison with the reference specimen. Thus, in option 4EM (with voltage U=1 kV) the yield was 3.75 % higher than that of the reference specimen, in 5EM (U=1.65 kV): 4.72 % higher, and in 6EM (U=3 kV): 9.32 % higher. Therefore the yield was increased by additional quantities of grain, as follows: 233.2 $kg.ha^{-1}$ in 4EM, 293.6 $kg.ha^{-1}$ in 5EM, and 579.7 $kg.ha^{-1}$ in 6 EM.

The data analysis for the obtained yield from the variety Enola after treating the seeds by options No.1 and No.4 reveals the following. In both mentioned options the values of the controllable factors were the same: voltage U=1 kV and duration of impact τ=10s. The difference was in the degree to which the helical device was full, for option No. 1 it was 50%, for option No. 4: 5%. Under equal other conditions, the resulting yield in option No. 1 was 105.7 $kg.ha^{-1}$ higher than that of the reference specimen, while for No. 4 it was 233 $kg.ha^{-1}$higher, i.e. the yield had increased more than twice. Hence, the conclusion that the energy imparted to the seeds in the case of the device being 50% full was lower than in the case of the device being 5% full.

The studies in 2006/07 of wheat seeds of the variety Pliska (Sirakov et al., 2007), which were performed using the helical device (Terziev et al., 1995) showed that at a voltage level U=1 kV of the electromagnetic treatment, and duration of impact τ=10 s, the obtained yield was 8.5 % higher than that of the reference specimen. The difference between 3.75 % (after treatment of the variety Enola by treatment option 4EM) and the said 8.5 % could be attributed to the varietal specificities of the seeds and the higher susceptibility of seeds of the variety Pliska to the electromagnetic field impact.

In treatment option 8ES (Figure 2), the applied electric voltage U=7.5 kV for a duration of ES treatment τ=10 s contributed to the increase of the yield by 5.25%. This meant an increase in the yield of 326.6 $kg.ha^{-1}$.

As the voltage between the electrodes was increased to U = 11 kV during the electrostatic treatment (option 7 - Table 1), this lead to the reduction of the yield obtained, which was 97.75%/rs (Figure 2). Therefore, it can be concluded that the energy imparted to the seeds was higher than necessary and resulted in suppression of the generic properties of the seeds.

The analysis of the calculated variances used to determine the average yield shows that for the reference yield the resulting variance is s^2=0.053, while for all of the other treatment option it is within the range s^2=(0.02-0.15). In other words the obtained results are equally close to the calculated average yield.

A graphic expression of the results of the average yield study for wheat variety Kristy, as a percentage of the reference yield (%/rs), is given in Figure 3. The obtained average reference yield (treatment option No.13 – Table 1) from one experimental plot having an area of 15 m^2 was 11.79 kg (i.e. 7860 $kg.ha^{-1}$).

From Figure 3 it can be seen that the wheat seeds of the variety Kristy were not substantially influenced by the level to which the helical device was filled (Terziev et al., 1995) during the electromagnetic treatment. Compared to the reference yield, the yield obtained from them was as follows: for the treatment device 5% full - 102.88% in treatment option No.10, and for the treatment device 50% full - 102.20% in treatment option No.11. In other words, the yield increased by additional quantities of grain of 226.4 $kg.ha^{-1}$ and 172.9 $kg.ha^{-1}$ respectively.

The electrostatic pre-sowing treatment of the seeds of the variety Kristy, with applied electric voltage U=8.5 kV and duration of treatment τ=10 s, (option No.12 ES) resulted in suppression of the generic qualities. After such treatment, the yield was 95.25% of that of the reference specimen.

The difference in the yield volume of the two wheat varieties Enola and Kristy, after applying the same types of treatment with the same controllable factor levels, could be explained with the variety dependency of these varieties to the pre-sowing electric treatment of the seeds.

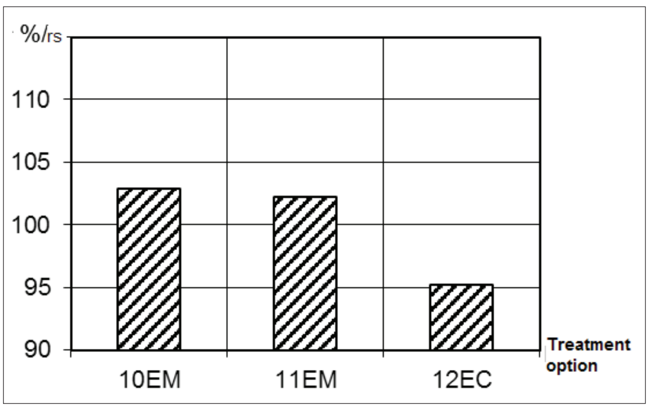

Fig. 3. Results of the study of the average yield (as a percentage of the reference yield, %/rs) of wheat variety Kristy in 2010/2011

Legend: 10EM - pre-sowing electromagnetic treatment with the device 5% full;
11EM – pre-sowing electromagnetic treatment with the device 50% full;
12EC – electrostatic pre-sowing treatment

Conclusions

It was confirmed that the used helical device for pre-sowing electromagnetic treatment could contribute to increasing the yields of the wheat varieties Enola and Kristy. A variety dependency to the pre-sowing electric treatment of wheat seeds of the varieties Enola and Kristy was found. With the helical device 5% full and for duration of impact τ=10 s at voltage U=1 kV, an increase of 233.2 $kg.ha^{-1}$ in the yield of wheat variety Enola was achieved; at U=1.65 kV the increase was 293.6 $kg.ha^{-1}$, and at U=3 kV: 579.7 $kg.ha^{-1}$. With the helical device 50% full and duration of impact τ=10 s at voltage U=1 kV, an increase of 105.7 $kg.ha^{-1}$ in the yield of wheat variety Enola was achieved. For the variety Kristy, regardless of the level to which the helical device was filled, for duration of electromagnetic impact τ=10 s at voltage U=1 kV an increase in the yield was achieved: 172.9 $kg.ha^{-1}$ and 226.4 $kg.ha^{-1}$ with the helical device full at 50% and 5%, respectively. By electrostatic treatment with duration of impact τ=10 s at voltage U=7.5 kV, an increase of 326.6 $kg.ha^{-1}$ was achieved in the yield of wheat variety Enola. At certain voltage values, for the both types of treatment – electromagnetic (1 kV and 1.65kV, when the screw device is up to 50% fill level) and electrostatic (8.5 kV and 11 kV) there are (1-5)% decrease of the yield for both studied varieties.

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