UDC: 632.93.631.531.1
original scientific paper

Acta Agriculturae Serbica, Vol. VII, 14 (2002) 25-32

Acta Agriculturae Serbica
FACULTY OF AGRONOMY • ČAČAK •

Seed Disinfection and Stimulation by Biophysical Methods

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Abstract: Large yield increases due to intensive use of chemicals mark the agriculture of the 20th century. At the same time, the intensive application of chemicals negatively affected the environment. The agriculture of the 21st century is expected to rely on biophysics which is more environment friendly than chemicals.

A study has been conducted to assess the effectiveness of electrons for seed disinfection as well as to assess the effect of resonance impulse electromagnetic stimulation (RIES) on agricultural crops yield increase. The following wheat varieties were used in a field trial: Renesansa, Durumka, Last and NS Rana 5. The trial included the following treatments: 1. seed disinfected by chemicals, 2. seed disinfected by chemicals + RIES, 3. seed disinfected by electrons, 4. seed disinfected by electrons + RIES. The other agrotechnical measures (planting and tending) were performed conventionally. The following yield components were analyzed at the end of the growing season: stem height, number of spikes per m^2, total number of spikelets per spike, mass of barren spikelets per spike, mass of seeds per spike, mass of 1000 seeds and seed yield per hectare. In both seed treatments with electrons, stem height was reduced by 0.46 and 0.15 cm, number of spikes per m^2 was reduced by 5 and 21 and the number of barren spikelets was reduced by 0.06. Compared against chemical disinfection, the electron treatment increased the number of spikelets per spike by 0.34, mass of seeds per spike by 0.08 g, mass of 1000 seeds by 0.47 g and 0.72 g and seed yield by 0.1 tha^{-1} and 0.14 tha^{-1}. RIES stimulation reduced stem height by 0.42 cm, number of spikes per m^2 by 18, number of barren spikelets by 0.11. At the same time, RIES stimulation increased the total number of spikelets per spike by 0.11, mass of seeds per spike by 0.03 g, mass of 1000 seeds by 0.15 g and seed yield by 260 $kgha^{-1}$.

Key words: wheat, hybrid, seed disinfection, biophysical methods, organic matter production.

Introduction

As a comparatively new science, biophysics is of paramount importance to agricultural production, with researches used in applied economy, cosmic assays and others.

Seed pollination is an unavoidable procedure today, implying the existence of a greater range of the chemicals. As an alternative mode, which is also ecologically convenient, the chemical pollination, the so called, e-treatment (>e< low energy electrons) was developed recently.

The Procedure Mechanism

The majority of cultivated plant seeds exist in their surficial layer or in the seeds themselves. Therefore, the seeds represent the centre of the electrons impact. The electrons ejected from the cathode are running over the free atmosphere, into which the seeds are released through a narrow passage. The electron energy is directed so as to pierce the defined surficial layer only.

The Best Merits of e-Treatment

No pollination means are needed, no toxic dust exists, pathogen resistance is excluded, the seeds remains may be used as fodders or stored, this method is also economically justified and ecologically more appropriate.

Materials and Method

The field trial was conducted in the trial field of the Scientific Institute of the Field and Vegetable Crops in Rimski Šamčevi, on the chernozem type of soil, of the proper chemical, physical and biological properties. Seed Disinfection was studied through the electrons and chemicals in combination with resonance impulse electromagnetic stimulation. The following varieties were examined: Renesansa, Durumko, Lasta and NS Rana 5 over the variants, as follows:

1. The seeds disinfected with chemicals;
2. The seeds disinfected with chemicals + RIES;
3. The seeds disinfected with electrons;
4. The seeds disinfected with electrons +RIES;

Taken agrotechnically, the experimental field was seeded within the optimal time, and a proper care was taken as usual. Over the milk-wax maturity phase, the plant specimens were taken from the two points of one row at 1 m of the distance, with the following elements being analysed: stem length (cm), the number of spikes, the total number of spikelets, the number of unfertile spikelets, the mass of barren grains per spike and (g) the mass of 1000 grains. The grain yield of t-ha^{-1} was determined by combine harvesting of the elementary plot, with the obtained results processed through the analysis of the factorial trial.

Discussion and Results

As can be seen from the table 1., stem length of the varieties in question, when subdued to the seed disinfection with the electrons, was averagely lower by 0,54cm on the variants without RIES and by 1,15 cm on those with RIES, with no statistically significant differences found. With RIES, the stem was on the average shorter by 0,58cm with the exception of the variety NS-Rana 5 and Durumko, the stems of which were increased by 1.12cm applying the electrons and by 0,9cm on the variants without RIES, with no significant differences manifested.

Tab.1. The Stem Length In Wheat (cm) in the Trial with E-treatment and Electromagnetic Stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		66,06	63,66	64,26	62,82
Durumko		64,12	65,03	64,46	64,47
Lasta		61,20	59,72	61,65	59,39
NS Rana 5		58,58	59,70	58,67	57,77
Prosek		62,49	62,03	62,26	61,11
Prosek		62.26		61.68	
LSD		A	B	A Δ B	B Δ A
	005	1,85	1,85	3,65	3,70
	001	2,65	2,46	4,94	4,91

The number of spikes per metre square is shown in the table 2.

Tab.2. The Number of Spikes/m^2 in the Trial with e-treatment and Electromagnetic Stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		555	587	555	577
Durumko		515	547	467	425
Lasta		597	567	582	606
NS Rana 5		620	567	647	555
Prosek		572	567	562	541
Prosek		570		552	
LSD		A	B	A Δ B	B Δ A
	005	6	5	10	10
	001	8	7	14	14

On average, compared to disinfection of the seeds, the application of the electrons brought about a lower number of the spikes. The difference of 5 per meter square was recorded in the variants without RIES, and that of 21 m per square meter in those with RIES. The variants with RIES averagely possessed 18 spikes less per m^2 . These differences are similar to those evidenced with the individual varieties, i.e. Lasta and NS Rana 5. In the other two varieties, the

variants with electron disinfection possessed more spikes per metre square. These differences were statistically insignificant.

The parameter of yield deserving mention is the number of spikelets per spike presented in the table 3.

Tab.3. The number of spikelets/spike in the trial with e-treatment and electromagnetic stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		17,41	17,71	17,51	17,47
Durumko		15,31	15,89	15,51	15,43
Lasta		16,28	16,28	16,42	16,28
NS Rana 5		15,87	16,36	16,56	16,83
Prosek		16,22	16,56	16,50	16,50
Prosek		16,39		16,50	
LSD		A	B	A Δ B	B Δ A
	005	0,26	0,37	0,74	0,71
	001	0,38	0,49	0,99	0,95

The electron seed disinfection of the individual varieties averagely exerted a slightly higher number of the spikelets per spike without RIES method, whereas the chemical disinfection induced their visibly higher number. Only RIES method could increase the number of spikelets per spike, in this case by 0,11. None of the above-mentioned differences were significant.

The number of the spikelets per spike is presented in the table 4. On average, the variants with the electron seed disinfection without RIES possessed a lower number of unfertile spikelets and *vice versa*. With the use of RIES method, the number of the unfertile spikelets averaged less. Statistically significantly higher number of the unfertile spikelets was recorded in the variant with RIES and with electron seed disinfection compared to the chemical disinfection in the variety Durumko. The rest of the differences were unimportant.

Tab.4. The number of unfertile spikelets/spike in the trial with e-treatment and electromagnetic stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		1,99	2,21	2,17	2,17
Durumko		1,90	1,50	1,19	1,74
Lasta		1,86	1,59	1,74	1,56
NS Rana 5		2,01	2,21	1,82	2,05
Prosek		1,94	1,88	1,73	1,88
Prosek		1,91		1,80	
LSD		A	B	A Δ B	B Δ A
	005	0,23	0,29	0,56	0,58
	001	0,32	0,39	0,75	0,77

Tab.5. The Mass of 1000 Grains over the Trial with e-treatment and Electromagnetic Stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		41,68	44,83	41,13	43,20
Durumko		49,38	49,33	50,55	50,15
Lasta		40,43	41,25	40,60	39,72
NS Rana 5		39,10	37,03	38,40	40,50
Prosek		42,64	43,11	42,67	43,39
Prosek		42,88		43,03	
LSD		A	B	A Δ B	B Δ A
	005	1,07	1,00	2,00	2,00
	001	1,54	1,33	2,66	2,70

The mass of 1000 grains averaged higher on the variants with RIES stimulation and disinfection via electrons, i.e. by 0,15; 0,47 and by 0,72 g, respectively. Taken by the individual varieties, the mass of 1000 grains was reported to be higher in the variety Renesansa in both cases (3,15 and 2,07g) and in the variety NS-Rana 5 on the variant with RIES (2,1g). In the same variety without use of RIES, the 1000 grain mass was reported to be higher with chemical disinfection (2,07 g). In terms of the individual varieties, these differences were insignificant.

Tab.6. The Mass of Barren Grains/Spike over the Experiment with e-treatment and Electromagnetic Stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		1,26	1,26	1,24	1,35
Durumko		1,28	1,36	1,31	1,28
Lasta		1,18	1,32	1,27	1,32
NS Rana 5		0,96	1,07	1,00	1,07
Prosek		1,17	1,25	1,20	1,26
Prosek		1,21		1,24	
LSD		A	B	A Δ B	B Δ A
	005	0,08	0,08	0,17	0,16
	001	0,12	0,11	0,22	0,22

Grain mass per spike (Tab.6) of the individual varieties was averagely remarkably higher in the variants with electron disinfection without RIES except for the variety Renesansa showing no deviation. With RIES and electron disinfection, the grain mass per spike was found to be higher in relation to that achieved with chemical disinfection, with no significant differences found.

The grain yield tha^{-1} (Tab.7) represents the result of the above-mentioned parameters. The application of the resonant impulse electromagnetic stimulation helped attain higher yield by 260 kg, noticeably differing from that in the variants without RIES. The electron seed disinfection, compared to the chemical one, resulted in the yield higher by 100 and 140 $kgha^{-1}$ (on average for

all the varieties). The difference of 130 kgha^{-1} (in both cases) was recorded in Renesansa, those of 290 and 260 kgha^{-1} in Lasta and those of 110 and 180 kgha^{-1} in NS-Rana 5. The exception to this was the variety Durumko of electromagnetic seed disinfection with the yield lower by 130 and 10 kgh^{-1} in relation to that obtained with chemical disinfection, with no statistical significance manifested.

Tab.7. Wheat Yield (tha^{-1}) over the Trial with e-treatment and with Electromagnetic Stimulation

Varieties		Experimental variants			
		H	E	H+RIES	E+RIES
Renesansa		6,88	7,01	7,11	7,24
Durumko		7,48	7,35	7,68	7,67
Lasta		6,03	6,32	6,27	6,53
NS Rana 5		5,55	5,66	5,83	6,01
Prosek		6,48	6,58	6,72	6,86
Prosek		6,53		6,79	
LSD		A	B	A Δ B	B Δ A
	005	0,21	0,26	0,67	0,64
	001	0,20	0,38	0,89	0,87

The obtained results are in agreement with those obtained by Marinković (1999., 2000., 2002), Malešević et al., (2001., 2002), Milošev et al., Grigorev et al., (1998), Maronek D.M. (1975) as well as with those of Von Jan Tigges et al., (2002).

Conclusion

The interactive impacts of the resonant impulse electromagnetic stimulation and the low energy electron seed disinfection (e-treatment) suggest the following:

- Compared to chemical method, RIES and e-treatment reduced stem length by 0,54 and by 1,15cm.
- The number of spikes per m^2 was decreased by 5 and 21 using the above mentioned two methods.
- The total number of spikelets per spike was increased by 0,34 spikes combining RIES and e-treatment.
- The number of unfertile spikelets was reduced by 0,06 in the variants without RIES, and raised by 0,15 in those with RIES.
- Chemical disinfection reduced the mass of 1000 grains by 0,47 and 0,72 in relation to that obtained with e-treatment with and without RIES.
- In the variants with e-treatment (seed disinfection), grain yield per spike was increased by 80 and 60 mg with and without RIES.
- Grain yield was higher by 100 kgha^{-1} in the variants with e-treatment and by 110 and 290kgha^{-1}, respectively, in the individual varieties.
- RIES method increased grain yield by 280 and 350 kgha^{-1} (averagely by 260 kgha^{-1}).

Speaking about biophysical methods of the seed e-disinfection and RIES stimulation either individually or combined, they have justified their significance fully so far and may unambiguously present the methods of the future.

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DEZINFEKCIJA I STIMULACIJA SEMENA BIOFIZIČKIM METODAMA

- originalni naučni rad -

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Rezime

Veliki porasti prinosa usled intenzivne primene hemijskih materija obeležavaju poljoprivredu 20.veka. Istovremeno se intenzivna primena hemijskih materija negativno odrazila na sredinu u kojoj živimo. Očekuje se da se poljoprivreda 21. veka oslanja na biofiziku koja više doprinosi očuvanju sredine nego hemikalije.

Izučavanje je vršeno radi ocene efikasnosti dezinfekcije semena elektronima, kao i ocene uticaja rezonantno impulsne elektromagnetne stimulacije (RIES) na povećanje prinosa poljoprivrednih useva. Korišćene su sledeće sorte pšenice u poljskom ogledu, Renesansa, Durumka, Lasta i NS Rana 5. Ogled je obuhvatio sledeće tretmane, 1. dezinfekcija semena hemikalijama, 2. dezinfekcija semena hemikalijama + RIES, 3. dezinfekcija semena elektronima 4. dezinfekcija semena elektronima +RIES. Druge agrotehničke mere (sadnja i nega), vršene su klasično. Na kraju sezone gajenja analizirane su sledeće komponente prinosa – visina stabla, broj klasova po m^2, ukupan broj klasića po klasu, masa klasića po klasu, masa semena po klasu, masa 1000 zrna i prinos zrna po ha. U oba tretmana semena elektronima, visina stabla je smanjena za 0,46 i 0,15 cm, broj klasova po m^2 je smanjen za 5 i 21, a broj klasića za 0,06. U odnosu na hemijsku dezinfekciju, tretman elektronima povećao je broj klasića po klasu za 0,34, masu semena po klasu za 0,08g, masu 1000 zrna za 0,47 g i 0,72 g i prinos semena za 0,1 tha^{-1} i 0,14 th^{-1}. RIES stimulacija je snizila visinu stabla za 0,42 cm, broj klasova po m^2 za 18, broj klasića za 0,11. Istovremeno je RIES stimulacija povećala ukupan broj klasića za 0,11, masu semena po klasu za 0,03 g, masu 1000 zrna za 0,15 g i prinos semena za 260 $kgha^{-1}$