EFFECT OF COLD ELECTRON PLASMA AND EXTREMLY LOW FREQUENCY ELECTRO-MAGNETIC FIELD ON WHEAT YIELD

UTICAJ HLADNE PLAZME ELEKTRONA I ELEKTRO MAGNETNOG POLJA EKSTREMNO NISKOH FREKFENCIJA NA PRINOS PŠENICE

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Abstract: *This thesis showed results of applied "electron plasma" and "emp enf" method. Three wheat variety seeds (durumko, renesansa and pobeda) were disinfected with electron plasma and treated just before sowing with low frequency electromagnetic field (from 0-100 hz). For seed disinfection we also used pesticides, for comparing and we sowed seeds without disinfection (control for all treatments). Electron treatment didn't have significant effect on yield in compare to chemical disinfection treatment; the difference was 30kgha^{-1}. However, justification of this treatment is more important from ecological viewpoint. Treatment with extremely low frequency electro-magnetic field, increased wheat yield for270 kgha^{-1} in compare to untreated seed.*

Izvod: *U radu su prikazani rezultati uticaja primene "plazme elektrona" i "emp enf" metode. seme tri sorte pšenice (durmko, renesansa, i pobeda) dezinfikovano je primenom plazme elektrona, a neposredno pred setvu stimulisano je elektromagnetnim talasima niskih frekvencija (raspona od 0-100 hz). uporedo sa primenom elektrona, za dezinfekciju semena upotrebljeni su i hemijski preparati kod kontrolne varijante, kao i setva semena bez dezinfekcije (kontrola za sve tretmane). tretman elektronima nije imao značajnog uticaja na prinos (30 kgha^{-1}) u odnosu na hemijske mere dezinfekcije. međutim, opravdanost primene elektrona sa ekološkog stanovišta mnogo je značajnije. tretmani elektomagnetnim poljem ekstremno niskih frekfencija povećali su prinos pšenice za 270kgha^{-1} u poređenju sa netretiranim semenom.*

Key words: *wheat, seed treatment, EMP ENF, electrons*
Ključne reči: ***pšenica, tretiranje semena, EMP ENF, elektroni***

INTRODUCTION

At the end of 20 th century, due to development of scientific thought, colossal discoveries have been made. Till now, it was unthinkable to use physics in agriculture. In actual terminology it is called biophysics. Speed electrons-plasma electrons have their own place in disinfection, and extremly low frequencies in plant stimulation. The task of this methodes is obtaining ecological product, yield increase, and product of better quality.

Tendency of these investigations is to study effect of speed electrons in seeds disinfection and effect of electromagnetic stimulation in yield increase.

MATERIALS AND METHODS

Plot was carried out on trial at Rimski Sancevi in Institute of Field and Vegetable Crops. Researches were caried out on soil type chernozem, subtype carbonate, variation medium deep. In this experiment three wheat varity were examined (Renesansa,Durumko and Pobeda) with the next variants: 1. control (seeds without disinfection), 2. chemical disinfection of seeds, 3. chemical disinfection of seeds + ELF EMF (Extremly Low Frequencies Electromagnetic Field), 4. e disinfection (disinfection with speed electrons), 5. e disinfection + ELF EMF.

Just before seeding, seeds were disinfected with speed electrons (electron plasma) and treated with extremly low frequencies electromagnetic field (to 100 Hz). Then it was disinfected with chemical preparation Dividend. After that, seeds were sowed, in optimal term in both years of examinations. Fertilization and the others agricultural measures were caried out like standard measures for crop production on all examined variants.

Obtained results (grain yield tha $^{-1}$ and number of grains) were worked out with analysis of variance factorial split-plot traial.

RESULTS AND DISCUSSION

Seed yield (tha^{-1}) *Table 1.*

Variety	Treatments						Average
	Ø	H	e	EMP ENF	H + EMP ENF	e + EMP ENF	
Renesansa	10.07	9.57	9.61	10.28	9.89	10.07	9.95
Durumko	10.62	10.23	10.27	10.89	10.69	10.67	10.59
Pobeda	8.82	8.39	8.42	9.15	8.72	9.09	8.82
Average	9.84	9.40	9.43	10.11	9.77	9.94	
Double Average	H and H+EMP ENF		e and e+EMP ENF		H and e		H+EMP ENF and e+EMP ENF
	9.74		9.77		9.53		10.03
LSD			A		B	AxB	BxA
	005		0.29		0.36	0.93	0.89
	001		0.42		0.53	1.24	1.21

The highest grain yield, on average for all treatments was achieved in variety Durumko (10.59 tha^{-1}) (Table 1).

In comparison with varieties Renesansa and Pobeda, the yield difference was highly significant.

Variety Durumko achieved the highest yield in EMP ENF treatment (10,89 tha^{-1}), and the lowest in the treatment of chemical disinfection of seeds (10.23 tha^{-1}) (Table 1.).

With all three varieties, the highest yield was achieved in EMP ENF treatment, and the lowest in chemical seeds disinfection.

On average, with all three varieties the difference between EMP ENF treatment and chemical seeds disinfection treatment was highly significant.

Double averages showed that in all variants when electromagnetic field of extremely low frequencies was applied (H and H+EMP ENF, e and e+EMP ENF, H+EMP ENF and e+EMP ENF) a higher yield was achieved in comparison with chemical and electron treatments.

The highest yield differences were observed between treatments H+EMP ENF and e+EMP ENF (10.03 tha^{-1}) and treatments H end e (9.53 tha^{-1}). The differences were not statistically significant. (Table 1.)

1000 seeds mass (g) *Table 2.*

Variety	Treatments						Average
	Ø	H	e	EMP ENF	H + EMP ENF	e + EMP ENF	
1	43.59	41.93	42.94	42.34	41.93	42.91	42.61
2	50.83	51.66	50.91	51.43	50.28	51.31	51.07
3	40.40	41.13	42.32	42.22	41.29	41.66	41.50
Average	44.94	44.91	45.39	45.33	44.50	45.29	
Double Average	H and H+EMP ENF		e and e+EMP ENF		H and e		H+EMP ENF and e+EMP ENF
	44.71		45.34		45.15		44.90
LSD		A		B		AxB	BxA
	005	0.55		0.56		1.11	1.09
	001	0.73		0.73		1.46	1.44

1000 seeds mass (Table 2.), in varieties tested, ranged from 51.07 g in variety Durumko to 41.50 g in variety Pobeda.

The differences between variety Durumko and varieties Renesansa and Pobeda were highly significant.

In variety Pobeda, the highest 1000 seeds mass (45.39 g) was recorded with e-disinfection treatment, while the lowest mass (44.50 g) was recorded with H + EMP ENF treatment (Table 2.).

Average 1000 seeds mass (44.50 g), in treatment H + EMP ENF, was smallest in comparison with other treatments and with the control treatment (without disinfection).

Observing the double averages, the largest 1000 seeds weight was recorded in treatment e and e+EMP ENF (45.34 g) (Table 2.).

The difference between the lowest 1000 seeds mass on H and H+EMP ENF treatment (44.71 g) was not statistically significant (Table 2.).

Hectolitre mass (kg) *Table 3.*

Variety	Treatments						Average
	Ø	H	e	EMP ENF	H + EMP ENF	e + EMP ENF	
Renesansa	84.77	85.55	85.36	85.16	85.36	85.26	85.24
Durumko	83.30	83.20	83.20	83.01	83.40	83.40	83.25
Pobeda	84.08	84.38	84.18	84.28	84.28	83.99	84.20
Average	84.05	84.38	84.25	84.15	84.35	84.21	
Double Average	H and H+EMP ENF		E and e+EMP ENF		H and e		H+EMP ENF and e+EMP ENF
	84.37		84.23		84.32		84.28
LSD		A		B		AxB	BxA
	005	0.13		0.09		0.18	0.19
	001	0.21		0.12		0.24	0.26

On average for all treatments, the highest hectoliter mass was recorded in variety Renesansa (85.24 kg) (Table 3.).

Variety Renesansa hectoliter mass was statistically significantly higher in comparison with the other two varieties tested. Variety Renesansa (85.55 kg) and variety Pobeda (84.38 kg) recorded the highest hectoliter mass in chemical disinfection seeds treatment (Table 3.).

Variety Renesansa recorded the smallest hectoliter mass in the control treatment (84.77 kg), and variety Pobeda in e + EMP ENF treatment (83.99 kg) (Table 3.).

In both treatments the differences were highly significant.

On average for all treatments, the highest hectoliter mass was recorded in chemical seed disinfection treatment (84.38 kg) and that difference was not statistically significant (Table 3.).

In double averages the highest hectoliter mass was obtained in treatment H end H+EMP ENF (84.37 kg) (Table 3.).

However, the difference was not statistically significant, not even in comparison with the treatment e end e+EMP ENF (84.23 kg) that recorded the lowest hectoliter mass (Table 3.).

Twentieth century agriculture was marked by intensive use of chemical products, which has resulted in a significant increase of yields but has at the same time led to the endangerment of agro ecosystems. Although the potentials of conventional crop growing technologies have not been fully exhausted yet, new approaches have started to appear in agricultural production. The 21st century in agriculture will be marked by new technologies, and these will without a doubt include biophysical methods.

Until as recently as 15 years ago, which was when we began our work on the application of extremely low-frequency (ELF) electromagnetic fields (EMF) in agriculture, many physicists insisted that such low frequencies were incapable of producing any significant effect in plants. Nowadays, however, a critical number of findings have been obtained that clearly identify changes occurring in plants as a result of biophysical influences According to Marinković *et all*. (2002, 2003), the nature of the effect also depends on the hybrid, seasonal biological rhythms, field frequencies, period of exposure, and geomagnetism of the micro site. Kalinin (2001) indicates ELF-EMF may have: **I** energetic effects, **II** biophysical and biochemical effects, **III** informational effects.

The great amount of attention given to the effects of the electromagnetic field in agriculture has been due to the possibility of being able to exert influence on plant growth and thus produce significant economic effects.

A study conducted in Urbino, Italy by Piacentini. (2001) showed that there is an interaction between ELF-EMF and biological systems. The interaction starts at the cell membrane level and proceeds further from there. The study was performed on cells undergoing mitosis and the growth and development of the whole plant was found to be affected. It was determined that ELF-EMF affects the phosphoinositide signal that triggers transduction, activating phosphoinositide-dependent phospholipids C, which reduces the concentration of phosphatidylinositol-4,5-biphosphate.

Marinković *et all*. (2002, 2003, 2004, 2006) obtained significant results using ELF-EMF on wheat and barley. The above-ground weight of the seedlings increased by an average of 23.5%, while root weight increased by 46%. The yields, in small-plot trials and commercial growing conditions increased by 310-1,620 $kgha^{-1}$, while the protein content grew by 0.09-0.56%. Grzegorz and Leszek (2006) reported statistically significant increases of 3.0 and 4.1% in naked barley and oats, respectively. The protein percentage increased by 1.5-5.3%. Aksynov (2001) found that ELF-EMF affected wheat germ inability and caused changes in germination, viscosity, pH value, and esterase activity. In a study on wheat conducted by Phirke *et all.*

(1996), the best results were obtained by rotating a magnetic disc at 800 rpm for 21-22 minutes with a magnetic field strength of 0.10 T.

Studies of ELF-EMF in maize carried out by Marinković *et all.* (2002, 2003) showed that ELF-EMF increased seedling root weight by 37% and above-ground weight by 31% . In commercial growing conditions, grain yields were increased by 980-1,616 $kgha^{-1}$ (8.4-18.7% on average across six localities). Crnobarac *et all*. (2002) reported increases of sunflower yield ranging from 222 to 390 $kgha^{-1}$ and an increase of seedling weight of 21-38%. Kalinin (2001) achieved similar results with a 3 KVT generator and 245 MHz frequency. Crnobarac *et all.* (2002) reported that soybean yields increased by 306-658 $kgha^{-1}$ and that the increases in trials were 110-1,440 $kgha^{-1}$. Similar results were reported in a paper by Vakharia *et all*. (1991) that studied magnetic field effects in peanut. In the study, pod yield grew from 8.3 to 9.3 and 10.2 g/plant, and plant luxuriance, root length, and oil content increased as well.

In a study of sugar beet carried out by Marinković *et all*. (2002), taproot yield grew by 4.3 to 20.6 tha^{-1} and sugar content increased by 0.56-1.81%. The yield of sugar increased by 950 $kgha^{-1}$ on average.

Marinković *et all*. (2002) cited potato yield increases of 2.5-6.6 tha^{-1}, Gvozdenović (2002) reported a pepper yield increase of 15 tha^{-1} on average, and Takač *et all.* (2002) obtained an average yield increase of 3.1 tha^{-1} in tomato. Piacentini (2001) obtained similar results with cucumber. Namba (1998) studied the influence of 1-100 Hz 500 μT ELF-EMF in buckwheat, green shiso, radish, and Welsh onion and determined that each of the species had its own ideal ELF-EMF range (in radish, for example, the 1 Hz increased germ inability by 30%). Spilde (1989) observed that ELF-EMF may have not only a stimulatory but also an inhibitory effect on germ inability. According to Vasilevski (2003), laser treatments of carrot increased the yields of this crop by 0.78-2.55 kgm^{-2}.

Taro (2004) defines electrons with energy of less than 300 keV as low-energy electrons, or so-called soft electrons. Such electrons have been shown to have a number of advantages over gamma rays when used in the process of grain disinfection. The specific amount of energy used will vary depending on seed morphology. Thus, 60 keV are used for brown rice, 75 keV for wheat, 100 keV for white pepper, coriander, and basil, and 210 keV for black pepper. The use of electrons with such energies has been found to have no significant effect on seed quality. The first applicable treatments in this field have been developed by the Schmidt Seeger AG company and the Fraunhofer Institute for Electron Beam and Plasma Technology, as reported by Cutrubinis (2005). Setsuko *et all*. (2000) obtained similar results using a voltage of 170-190 kV for seed disinfection. Voltages of 200 kV and above inhibit germination. Similar results were obtained by Takashi *et all.* (2004). The importance of microwave fields in seed disinfection is convincingly demonstrated by the findings of Kalinin (2001) as well.

CONCLUSIONS

The highest grain yield, on average for all treatments was achieved in variety Durumko (10.59 tha^{-1})

The highest yield, with all three varieties, was achieved in EMP ENF treatment, and the lowest in chemical seeds disinfection.

In varieties tested, 1000 seeds mass ranged from 51.07 g in variety Durumko to 41.50 g in variety Pobeda.

1000 seeds mass were higher in e-disinfection treatment, EMP ENF treatment and e + EMP ENF comperinig with chemical seed disinfection.

Variety Renesansa hectoliter mass was higher in comparison with the other two varieties tested.

The highest hectoliter mass, on average for all treatments, was recorded in chemical seed disinfection treatment (84.38 kg).

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