1st International Conference
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ICCBIKG 2021

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BOOK OF PROCEEDINGS

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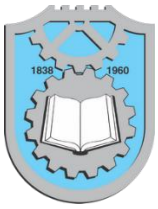

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POSSIBILITY OF APPLICATION PULSATING ELECTROMAGNETIC FIELD IN A SAFER SOYBEAN PRODUCTION

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Abstract:

The application of methods in the field of biophysics, such as the pulsating electromagnetic field (PEMP) to biological organisms, many studies are performed that indicate specific changes and efficient action on various biochemical processes of cells in plants. The obtained results do not depend only on the plant species, but also on the climatic conditions, agrotechnical measures and exposure time, intensity and nature of the fields used in the research. The aim of the study was the effect of stimulation of soybean seeds with PEMP. Soybean seeds are rich in quality proteins, oils and fats. The three-year research period 2013-2015 implied different agrometeorological conditions. Soybean seeds of the Valjevka variety were used. Soybeans were grown with different amounts of organic granular poultry manure (control - no fertilization, 750 kg.ha^{-1} i 1300 kg.ha^{-1}). Seed stimulation was performed before sowing with PEMP low frequency 15 Hz and exposure of 30 minutes. Seed stimulation efficiency was very pronounced because it statistically significantly ($p < 0.01$) increased grain yield by 4.85% and protein content in grain by 3.52%.

Key words: soybean, biophysics, pulsating electromagnetic field, yield, proteins

1. Introduction

Reports on the beneficial effects of pulsating electromagnetic field (PEMP) on seed germination, morphological and productive properties of plants introduce the use of pulsating magnetic field as one of the environmentally friendly techniques that meet the requirements of organic agriculture [1]. Many authors conclude that when energy is introduced into cells, molecular transformations are created, which can lead to an increase in the electropotential of membranes [2], a faster process of photosynthesis and an increased content of pigments [3], intensive cell division, which leads to faster uptake of water and nutrients needed by plants [4], as well as to processes involving free radicals by stimulating the activity of proteins and enzymes [5]. Therefore, the aim of this study is to examine the stimulation of soybean seeds before sowing with a pulsating electromagnetic field of low frequency on grain yield and protein content in grain in different agroecological conditions.

2. Material and Methodes

The research was conducted in the open field, a demonstration property of the Institute of Field and

Vegetable Crops in Novi Sad, Vojvodina - Serbia region, according to a split plot system in 4 replicates with a randomized design. The research period was 2013-2015. Soybean seeds of the Valjevka variety were stimulated. For each subparcel, 500 grains were prepared, which were stimulated by a pulsating electromagnetic field.

The three-factorial experiment consists of factor A, which consists of years of research, because climatic conditions affect the vegetative and generative growth of soybeans. Factor B is the amount of fertilizer: Ø (control), 750 kg.ha^{-1} and 1300 kg.ha^{-1}. Factor C is the treatment of seed stimulation by pulsating electromagnetic field (PEMP), frequency of 15 Hz and exposure of 30 minutes, which was done immediately before sowing. Soybean seed stimulation was performed using a pulse generator and a strip applicator (maximum frequency up to 100 Hz and maximum duration up to 1 h), through which the process of pulsating alternating movement of electric and magnetic fields takes place.

After harvest, the yield in kg.ha^{-1} was measured with a moisture content of 14%, while the protein content (%) was measured by chemical analysis using a DA-700 FLEXI-MODE NIR / VIS spectrophotometer. The results of the research were processed by statistical analysis of the variance of the three-factorial experiment, and the statistical significance of the differences tested by the LSD test at 5% and 1% (Statistical Program "Statistics 10.0"). The results are shown in a table.

3. Results and Discussion

Based on the results of the research, it was determined that the age factors and seed stimulation with PEMP had a highly significant effect on soybean grain yield, while the influence of the interdependence of the examined factors was not determined (Table 1). The average soybean yield was 3400,70 kg.ha^{-1}. The highest yield was determined in 2014. In arid 2015, the lowest yield was determined, 48.99% lower than in 2014, and 44.66% lower than in 2013. Numerous studies show a strong influence of environmental factors on soybean grain yield. Fertilization did not statistically significantly affect the yield. Seed stimulation had a statistically significant effect. With seed stimulation, the average increase in yield was 4.85% than in the control variant. The impact of PEMP in years that are not favorable for soybean production is very significant.

Table 1. Influence of testing on grain yield

Year (A)	Fertilization (kg ha^{-1}) (B)	Seed stimulation (C)		AB	A
		With out PEMP	With PEMP		
2013	0	2878,63	3063,33	2970,98	2989,68
	750	2925,15	3059,99	2992,57	
	1300	2978,01	3032,99	3005,50	
	AC	2927,26	3052,10		
2014	0	4984,51	5302,28	5143,39	5145,80
	750	5065,34	5222,99	5144,16	
	1300	5087,80	5211,92	5149,86	
	AC	5045,88	5245,73		
2015	0	1961,99	2174,59	2068,29	2066,60
	750	1961,15	2144,48	2052,82	
	1300	2038,72	2118,66	2078,69	
	AC	1987,29	2145,92		
BC	0	3275,04	3513,40	3394,22	
	750	3317,21	3475,82	3396,52	
	1300	3368,18	3454,53	3411,35	
	C	3320,14	3481,25		
Average 2013 - 2015				3400,70	

	A**	B^{ns}	C**	AB^{ns}	AC^{ns}	BC**	ABC^{ns}
LSD 0,05	51,75	34,81	25,99	60,30	45,01	45,01	77,97
LSD 0,01	60,88	47,70	35,09	82,62	60,79	60,79	105,28

The obtained results are compatible with studies where PEMP frequencies were used on soybeans of 72 Hz for 60 minutes and 16 Hz for 30 minutes [6], then the influence of PEMP in the range of 10 to 100 Hz of different duration and in other wheat plant species [7], cotton [8], lettuce [4].

On average for all three examined years, the average protein content in the grain was 39.28% (Table 2). Meteorological conditions, especially temperatures and precipitation, affect the protein content of soybeans. The favorable ratio of average air temperatures and the amount of precipitation in 2014 had a positive effect on the protein content (39.85%), which is also higher by 1.19% than in 2013 and 3.23% higher than in arid 2015. years. Different amounts of fertilization affected the variability of soybean protein, but the differences obtained were not at the level of statistical significance. The efficacy of seed stimulation with PEMP was very pronounced. Protein content during seed stimulation (39.96%) was 3.52% higher than without seed stimulation (38.60%).

Table 2. Influence of testing on grain protein content

Year (A)	Fertilization (kg ha^{-1}) (B)	Seed stimulation (C)		AB	A
		With out PEMP	With PEMP		
2013	0	39,05	39,37	39,21	39,38
	750	38,83	40,25	39,54	
	1300	38,83	39,96	39,39	
	AC	38,90	39,86		
2014	0	39,06	40,02	39,54	39,85
	750	38,65	41,26	39,95	
	1300	39,18	40,95	40,06	
	AC	38,96	40,74		
2015	0	38,80	38,88	38,84	38,60
	750	38,83	39,21	39,02	
	1300	36,17	39,75	37,96	
	AC	37,93	39,28		
BC	0	38,06	39,43	39,20	
	750	38,77	40,24	39,50	
	1300	38,97	40,22	39,14	
	C	38,60	39,96		
Average 2013 - 2015				39,28	

	A**	B^{ns}	C**	AB^{ns}	AC^{ns}	BC**	ABC^{ns}
LSD 0,05	0,70	0,83	0,64	1,43	1,10	1,10	1,90
LSD 0,01	0,82	1,13	0,86	1,96	1,49	1,49	2,58

In a multi-year study, applications with a 16 Hz PEMP frequency and exposure of 30 to 90 minutes led to an increase in protein yield of 2.18% to 6.78%, compared to the control [9]. Likewise, stimulation of seeds with low frequencies of 1.0 Hz PMF also leads to an increase in biomass, sugar, protein, phenol, flavonoids, and soybean grain alkaloids [10].

5. Conclusion

According to the obtained results, it can be concluded that the effects of the pulsating electromagnetic field have a positive effect on increasing the yield and protein content in soybean grain. The advantage of using electromagnetic treatments as biostimulators is the potential to change conventional plant production systems, to eliminate chemical inputs and toxic residues, which is positively correlated with new world trends in order to protect the environment and produce safe food. What is important to point out is the statistically highly significant influence on the examined parameters in the conditions of climate change when the water deficit is pronounced.

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