Hop garden experiments with an electromagnetic pulse field (EMF)

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Abstract
The aim of the project was a system for streamlining plant production and microbiological processes through an electromagnetic pulse field (EMF) which is patented by the Agency for Intellectual Property of the Republic of Uzbekistan (IAP 05796 of 2019). Due to this system, it was expected to achieve an increase in yields of plant production. High trellises commonly used in hop fields can be used as conductors of electromagnetic fields. The subject of interest on Saaz hop variety was standard monitoring of growth, evaluation of yield, alpha acids, nitrate contents and pesticide screening of hop cones.

The transmitters had been operating since beginning of June until harvest (2021–2023). Based on the results from previous years, the exposure time of EMF was adjusted each year. Hop cultivation and protection were carried out the same way as control variant, the experimental plots were influenced only by the transmitters. Three-years long observation did not show any significant effect on the quantitative and qualitative indicators of Saaz hops.

Key words. Electromagnetic pulse field, Saaz variety, yield, quality.

Material and methods
Experimental area is located at a hop garden of Hop Research Institute's Farm in Stekník. Saaz variety was used for this experiment.

The aim of the experiment was to test the effect of EMF on hop yield, alpha-bitter acids contents, nitrate contents and pesticides screening.

A unified cultivation technology, including plant protection, was held on experimental and control sites. The experimental and control parts of the hop garden were irrigated (as required) by a drip irrigation placed on the ceiling of the structure.

Random plants were chosen for harvest. Number of bines on each wire was counted. Hops harvested from each plant was weighed and recalculated on weight from one bine and weight of dry hops from 1 hectare.

A sample of hops was taken from each variant during harvest and analyzed for alpha-acids content (ČSN 46 2520-15, Determination of alpha bitter acid by the conductometric method).

Samples of dried hop cones were taken and analyzed for nitrate content (ČSN 46 2520-11 Testing of hops - Part 11: Determination of nitrates by the ionic liquid chromatography method).

One mixed sample of dried hop cones were taken and analyzed for pesticides screening (method of liquid chromatography with tandem mass spectrometry (LC-MS/MS)).

Year 2021 – variant of the experiment
The EMG was activated on June 30, 2021, and has been operating continuously until the last day before the harvest, i.e. August 24, 2021. Sampling 32 plants / variant.

Year 2022 – variants of the experiment
The transmitters were put into operation on June 19, 2022 (before the flowering phase) and have been affecting hops in various exposures until the last day before the harvest, i.e. August 23, 2022. Sampling 16 plants / variant.

Year 2023 – variants of the experiment
The transmitters were put into operation on June 13, 2023 (before the flowering phase) and have been affecting hops in various exposures until the last day before the harvest, i.e. August 20, 2023. Exposures included: A = 4 hours on, 4 hours off 2x, B = 2 hours on, 6 hours off 2x, C = 30 min on, 4.5 hours off 4x, D = always on, weak EMF. Sampling 16 plants / variant.

Results
See the table.

Table 1: Electromagnetic pulse field - RESULTS (Saaz hops)

Year	Variants	Yield	Index	Alpha-acids	Index	Nitrate	Index
		[t/ha]	[%]	[%]	[%]	[mg/kg]	[%]
2021	Control	2.4	100	4.42	100	8 247	100
	EMF	2.6	108	4.52	102	7 846	95
	Statistics (significance)		none		none		none
2022	Control	0.90	100	2.51	100	11 423	100
	EMF: 24 hours	0.68	75	2.47	98	10 938	96
	EMF-B: 6-18 hours	0.61	67	2.54	101	9 798	86
	EMF-C: 6-12 hours	0.86	95	2.40	95	10 915	96
	EMF-D: 6-9 hours	0.84	93	2.62	104	10 070	88
2023	Control	1.69	100	2.60	100	9 683	100
	EMF-A: 4 hours on, 4 hours off, 2x	1.57	93	2.38	91	9 628	99
	EMF-B: 2 hours on, 6 hours off, 2x	1.74	103	2.41	93	9 338	96
	EMF-C: 30 min on, 4,5 hours off, 4x	1.64	97	2.23	86	9 928	103
	EMF-D: always on, weak EMF	1.73	102	2.63	101	9 775	101

EMF generator installed in the hop garden (June 30, 2021).

Attaching the transmitter from the EMF generator to the hop pole (June 30, 2021).

Conclusion
Three-years long observation did not show any significant effect on the increase of quantitative and qualitative indicators of Saaz hops. Results of 2022 were negatively affected by a heat wave (over 40 °C) that caused an earlier end of prolongation of bines during June. Plants did not reach the top of the construction, were weak and the negative impact on yield was not caused by the EMF. The EMF did not significantly affect the degradation of pesticide active ingredients in plant protection products.

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