THE INFLUENCE OF LIGNOHUMAT ON SOME MORPHO-PHYSIOLOGICAL PROPERTIES AND ON MAIZE AND SOYBEANS PRODUCTION, IN THE SOIL AND CLIMATIC CONDITIONS OF IASI COUNTY

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Abstract
The experience was founded in 2010 in the Didactic Station of the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad" Iasi, Ezăreni farm. The research goal is to introduce a synthetic macromolecular compound in the technology culture. This compound is also found under the trade name Lignohumat. Lignohumatul is a foliar fertilizer containing up to 90 % humic acid particles. Most of Lignohumat weight, about 20 % is represented by sodium and potassium, elements that rely on hydroxide cations used in the technologic process of humat production. The experience is bifactorial, type A x B and is placed after the block method on one line, in three repetitions. A factor is the plant (maize and soybeans), and factor B is the Lignohumat dose applied (V_1 untreated, considered control, V_2 seeds and vegetation treatments depending on the culture). In maize two treatments were applied (100 g Lignohumat/10 l water / t seeds + 60 g / ha in the 3-4 leaf stage, in the same time with herbicides), and in the soybean crop were four treatments applied (100 g Lignohumat/10 l water / t seeds + 60 g / ha / 300 liters water in two-three leaves stage, before flowering phase and after flowering). We analyzed the influence Lignohumat on plant height, leaf chlorophyll content and the production of maize and soybean crops.

Key words: Humic substances, Lignohumat, chlorophyll content, maize, soybean

By approaching this theme we seek to increase the land productivity through the development, testing and implementation of sustainable technologies for growing plants adapted to local climatic features using a foliar fertilizer with a high content of humic substances (Lignohumat).

Also we follow to reduce the gap toward the average productivity of agricultural lands from the European Union.

Humic substances are defined as a general category of organic substances present in the wild, biogenic, heterogeneous, characterized by a color from yellow to black, with a high molecular weight (Aiken G. R. et al. 1985, quoted Perminova I. V., and Hatfield K., 2005).

Humic substances present similarities in composition, structure and properties with natural humic substances from soil and compost (Eyheraguibel et al., 2008).

Humic substances (humat), are widely used in agriculture. Regarding humic subtances the important part is their chemical properties of biopolymers such as: high capacity of cation and anion exchange, chelating ability, the ability to improve the functions of plant protection, and also to increase and develop their ability to interact with yeast from soil, vitamins and other substances.

In terms of composition of elements at the molecular level, of aromatization, the proportions of O/C and H/C and acidic functional groups (COOH and OH), Lignohumat has a high affinity to soil humic acids. The groups contained above are responsible for exchange capacity, chelating capacity and transport ability of chelated complexes by plants.

Lignohumat is one of the few substances whose solubility approaches 100 %, making it suitable for use in drip irrigation systems.

Lignohumat is achieved through the unique patented technology of accelerated humification of ligno-sulphonates. The process of converting lingo-sulphonates in humic products is made over 1,5-2 hours in oxidizing atmosphere, the whole technological process being supervised by a special program (Oleg Gladkov, Rodion Poloskin, 2010).

The humic acids together with clay minerals are considered among the most important inorganic soil components that provide adsorption of metals

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and other organic substances (Stevenson J. F., 1994; Tipping E., 2002; quoted by Stathi P., Deligiannakis Y., 2010). Humic acids also have adsorption and cation exchange capacity higher than the clay minerals.

Lignohumat applied at the foliar level leads to improved foliar nutrition of the plants, increases production, quality, capacity and energy for seed germination. In addition, it prevents stress generated by the treatment with pesticides, frost or drought effect on plants, improving growth, plant development and reducing the vegetation period.

Eyheraguibel B., et al., 2008, showed that humic substances do not increase the percentage or rate of maize seed germination, but increase root elongation these effects being due to the increased consumption of water and minerals by plants thus treated.

Mineralization of humic substances is stronger in soils with optimal moisture regime and well aerated, compared with compacted soils having high clay content (> 30-35%) (Rusu M., et al., 2005).

MATERIALS AND METHODS

The study began in 2010 in the Didactic Station of the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad" Iasi, Ezăreni farm (Plain of Moldavia 47° 07' N latitude, 27° 30' E longitude). The experience was located on a land with a slope of 3-4 %, a cambic chernozem soil type, clay-loamy, slightly acid pH, medium stocked in N and P_2O_5 and well stocked in K_2O *(tab. 1).*

Table 1

Soil chemical properties

Crop	Depth (cm)	pH	Humus %	Nt %	P AL mg/kg	K AL mg/kg
Maize	0-10	6,32	2,88	0,11	34,00	174,0
	10-20	6,40	2,88	0,10	23,00	171,0
	20-30	6,51	2,76	0,09	19,00	166,0
	30-40	6,51	1,50	0,07	6,00	149,0
Average 0-40 cm		6,44	2,51	0,09	20,50	165,0
Soybean	0-10	6,27	3,54	0,10	27,00	195,0
	10-20	6,29	2,94	0,11	27,00	192,0
	20-30	6,40	3,18	0,10	18,00	167,0
	30-40	6,72	2,70	0,08	8,00	155,0
Average 0-40 cm		6,42	3,09	0,10	20,00	177,3

Average yearly temperature is 9,4 °C and average annual rainfall is about 517,8 mm.

The experience is bifactorial, type AxB, being placed after the block method on one line, in three repetitions, occupying an area of 1200 m^2. The studied factors are the plant and the Lignohumat dose applied both to seeds and vegetation. Treatments were differently administered upon culture. In maize two treatments were applied (100 g Lignohumat/10 l water/t seeds + 60 g / ha in the 3-4 leaf stage, in the same time with herbicides), and in the soybean crop four treatments were applied (100 g Lignohumat/10 l water /t seeds + 60 g/ha / 300 liters water in 2-3 leaves stage, before flowering phase and after flowering).

The technology of culture was specific to the analyzed crops, such maize and soybeans. Fertilizers were given at a dose of 60 kg/ha P_2O_5 + 40 kg/ha, N before seedbed preparation and 20 kg/ha N in vegetation mechanical weed take, for maize and the entire amount of nitrogen administered before seedbed preparation the soybean crop. The seedbed was prepared on the day of sowing, using combinatorial and sowing were performed by SPC4-FS + U650 for maize and by SPC6 + U650 for soybean crop. Hybrids from Pioneer company were used, PR38A24 for maize and PR91M10 for soybean.

Leaf chlorophyll content was determined using the CCM device 200 plus (Chlorophyll Content Measurements) *(fig. 1).*

Measurements were made directly after crop rising in the experimental field, before flowering and after flowering.

Figure 1 **Chlorophyll Content Measurements (http://www.envcoglobal.com)**

The plant's height was determined after the crop rise before flowering, after flowering and before harvest, using the tape measure. The production was determined for each variant, expressed in kg/ha to STAS moisture. Statistical processing of experimental data was done using analysis of variance and F test.

RESULTS AND DISCUSSION

Humic substances are the most widely distributed organic substances in nature. Linked carbon content in soil humic acids, peat and coal is almost four times bigger than the linked carbon from organic substances related to flora and fauna around the world.

Lignohumat is a high performance humic fertilizer containing chelated micronutrients with and without ballast, acting as a stimulant to plant growth and anti-stress agent. Also it contributes to the growth of crops, resistance to drought and frost, increasing germination rate in soil and mineral fertilizer use efficiency (increases the utilization rate of nitrogen and phosphorus), which allows a dose reduction of fertilizer application approximately 20-30%.

From a climate perspective, the year under study is characterized by values of monthly average temperature and average relative humidity higher than normal for this area. Rainfall was distributed unevenly throughout the growing season *(fig. 2)*, with a peak in April and June and beginning with July the drought, was installed, with a peak in September *(tab. 2)*.

Table 2

Weather conditions in 2011

Month	Monthly average temperature (˚C)	Multi-annual mean temperature (˚C)	Monthly average relative humidity	Multi-annual mean humidity (%)	Average monthly rainfall (mm)	Multi-annual mean rainfall (mm)
I	-1,6	-3,6	93	81	13,6	28,9
II	-1,9	-1,9	80	79	4,0	27,4
III	4,1	3,3	74	72	11,2	28,1
IV	10,9	10,1	67	62	73,0	40,3
V	17,1	16,1	69	62	41,0	52,5
VI	20,9	19,1	72	63	88,2	75,1
VII	23,0	21,3	76	62	49,8	69,2
VIII	22,0	20,6	65	63	20,4	57,6
IX	19,3	16,3	68	66	11,8	40,8
X	9,7	10,1	78	73	30,8	34,4
XI	3,2	4,1	84	78	0,0	34,6
XII	2,9	-0,8	88	82	7,8	28,9
Average	10,6	9,6	76,2	70,3	29,3	43,2

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Regarding the maize plant height we obtained statistically significant differences between V_2 version on which there were applied Lignohumat treatments and V_1 version, considered a witness, on which were not applied any treatments *(tab. 3)*. Thus, we obtained significant distinct differences between V_2 and V_1 after plants rise, immediately after flowering and at harvest. In vegetation (before plants flowering), the differences were very significant. Very significant differences recorded before flowering are mainly due to the effect of treatment with Lignohumat conducted in phase of 3-4 leaves in maize.

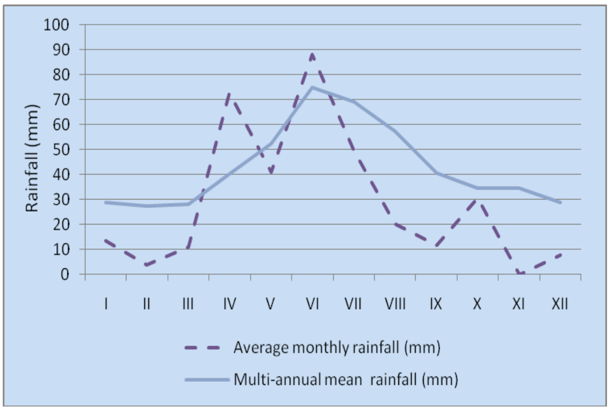

Figure 2 **The rainfall unevenly distribution throughout the growing season (2011)**

In the soybean crop we obtained statistically significant differences between V_2 and V_1. The differences were highly significant after plant rise and harvest. In vegetation (before and after flowering), the differences were not statistically significant.

The results regarding plant height in the analyzed crops showed a major influence of Lignohumat treatment on seed for both crops, maize, and soybeans respectively. Also, the positive effect of Lignohumat was seen in the entire growing season for soy culture, being the maximum at harvest.

Regarding the production, this is influenced by Lignohumat treatments especially in the maize crop, in which we obtained significant differences between variants V_2 (treated with Lignohumat) and V_1 (version control, untreated) *(tab. 4)*. In variant V_2 we obtained a yield of 9143 kg/ha, with 218 kg/ha more than in the control variant V_1 (8924 kg/ha) *(fig. 3)*.

In the soybean crop, the production differences were not statistically different between V_2 and V_1, with a difference of 54 kg/ha *(tab. 5)*. We obtained from V_1 3504 kg/ha and from V_2 we obtained 3558 kg/ha *(fig. 4)*.

While determining the chlorophyll content of the leaves we observed that the effect of Lignohumat treatment was greatest after plant rise, when there were statistically significant differences between the treated variant V_2 and the control version V_1 (very significant for the maize crop and distinctly significant for soybean culture *(tab. 6)*. During the growing and harvesting phases the differences were not statistically significant so that we can conclude that both maize and soybeans crops have used the Lignohumat treatment for the seeds at their best.

Table 3

The Lignohumat influence on plant height in maize and soybeans crops

Variant	MAIZE				SOYBEAN			
	S. 29.05	V. 01.07	V. 30.07	H. 27.09	S. 29.05	V. 01.07	V. 31.07	H. 27.09
V_1	45,5	201,0	239,7	235,3	12,5	46,0	78,3	100,7
	40,5	201,5	239,3	242,7	13,0	47,0	80,7	100,0
	44,0	199,5	250,0	241,0	15,0	46,5	81,7	100,7
	44,0	203,0	239,3	243,7	12,5	43,5	79,3	102,0
	42,0	197,0	239,3	250,0	14,0	45,0	80,3	100,3
	41,0	201,0	238,7	235,3	12,5	44,5	81,3	100,0
Average	42,8	200,5	241,1	241,3	13,3	45,4	80,3	100,6
STDEV	1,97	2,05	4,39	5,56	1,04	1,32	1,25	0,74
V_2	46,0	206,5	249,3	249,3	15,0	45,5	82,3	109,0
	47,0	209,5	253,3	254,0	15,5	46,5	81,0	109,0
	47,5	208,0	252,3	259,3	17,0	49,5	80,7	108,7
	49,5	207,0	255,7	253,3	16,0	46,5	81,3	109,0
	47,5	207,0	248,7	254,3	17,5	49,5	83,7	108,0
	46,0	210,5	245,0	247,0	17,0	47,5	83,7	108,7
Average	$47,3^{XX}$	$208,1^{XXX}$	$250,7^{XX}$	$252,9^{XX}$	$16,3^{XXX}$	47,5	82,1	$108,7^{XXX}$
STDEV	1,29	1,59	3,81	4,30	0,98	1,67	1,33	0,39
LSD 5 %	2,3	2,5	5,3	4,9	1,0	2,2	2,0	0,7
LSD 1 %	3,5	3,9	8,4	7,7	1,5	3,4	3,1	1,2
LSD 0,1 %	6,0	6,6	14,3	13,0	2,6	5,8	5,3	2,0

Table 4

The Lignohumat influence on maize production Variant	Production	% compared to control	Differences	Significance
V_1 Control (untreated)	8924	100,00	0,00	Mt
V_2 Lignohumat (100 g /10 l water / t seeds + 60 g / ha in the 3-4 leaf stage)	9143	102,45	218,50	XX

LSD 5 % = 109 kg/ha LSD 1 % = 171 kg/ha LSD 0,1 % = 291 kg/ha

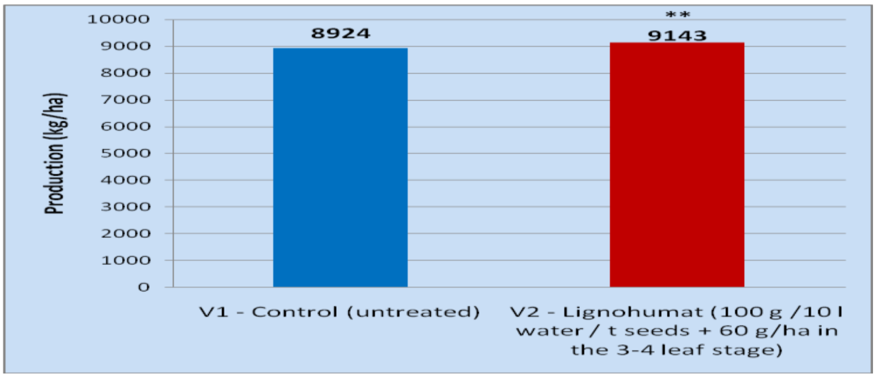

Figure 3 **The Lignohumat influence on maize production**

Table 5

The Lignohumat influence on soybean production Variant	Production	% compared to control	Differences	Significance
V_1 Control (untreated)	3504	100,00	0,00	Mt
V_2 Lignohumat (100 g /10 l water / t seeds + 60 g / ha / 300 liters water in 2-4 leaves stage, before flowering phase and after flowering)	3558	101,56	54,60	

LSD 5 % = 64 kg/ha LSD 1 % = 101 kg/ha LSD 0,1 % = 171 kg/ha

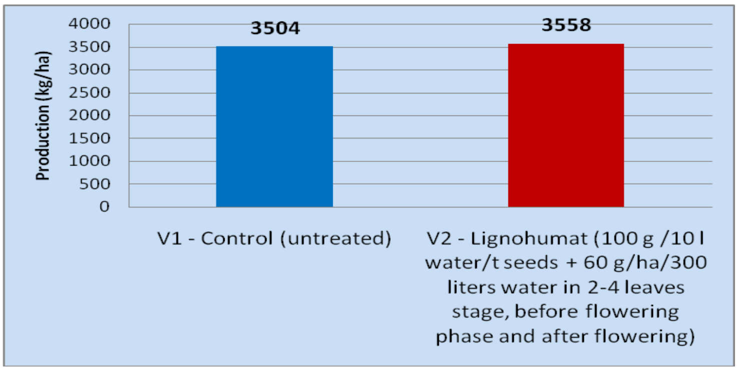

Figure 4 **The Lignohumat influence on soybean production**

Table 6

The Lignohumat influence on chlorophyll content of leaves in maize and soybean crops

Variant	MAIZE				SOYBEAN			
	30.05	02.07	31.07	Average	30.05	02.07	31.07	Average
V_1	42,5	52,1	59,1	51,2	16,8	25,3	36,6	26,2
	40,6	50,1	59,5	50,1	17,3	26,0	35,1	26,1
	40,4	53,7	53,0	49,0	16,2	26,1	34,5	25,6
	40,6	51,6	53,0	48,4	14,6	23,9	33,5	24,0
	42,5	51,6	64,5	52,9	15,2	26,0	31,0	24,1
	42,6	54,2	65,0	53,9	15,6	23,6	32,1	23,8
Average	41,5	52,2	59,0	50,9	15,9	25,1	33,8	24,9
STDEV	1,11	1,48	5,26	2,62	1,01	1,11	2,06	1,39
V_2	43,8	54,9	53,7	50,8	18,3	27,0	34,6	26,6
	43,1	57,1	61,8	54,0	18,8	24,8	31,7	25,1
	43,6	59,1	60,4	54,4	16,7	24,9	35,7	25,8
	43,9	57,8	62,0	54,6	15,7	26,2	35,7	25,8
	44,2	56,1	61,6	53,9	17,1	24,7	37,0	26,2
	45,4	53,3	63,9	54,2	17,4	26,5	37,0	27,0
Average	$44,0^{xxx}$	$56,4^{x}$	60,6	53,6	$17,3^{xx}$	25,7	35,3	26,1
STDEV	0,75	2,09	3,56	2,13	1,12	1,00	1,97	1,36
LSD 5 %	0,9	3,0	6,0	2,9	0,5	2,1	3,9	1,6
LSD 1 %	1,3	4,7	9,5	4,6	0,8	3,2	6,1	2,5
LSD 0,1 %	2,3	8,1	16,1	7,8	1,4	5,5	10,4	4,3

CONCLUSIONS

Regarding the chlorophyll content both cultures of leaves had a maximal benefit from the Lignohumat treatment for the seeds. Regarding the plant height and the production, the treatments with Lignohumat were better capitalized by the maize crop compared with soybean crop. Lignohumatul has the potential to be successfully utilized for the analyzed crops and possibly for other cultures.

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