THE INFLUENCE OF AQUASORB ON MORPHO-PHYSIOLOGICAL PROPERTIES ON CORN AND SOYBEANS YIELD, IN THE 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 crop. In this study we aimed to evaluate the influence of the hydrophilic polymer (Aquasorb) on some morpho-physiological properties and on corn and soybeans production, in the soil and climatic conditions of Iasi county. Our experience is polifactorial, resembling AxBxC type, being located by the randomized multilevel blocks method in three replications. The experimental factors are: the crop, the polymer dose and the administration time of the polymer. There were administered doses of 15 kg/ha Aquasorb on the variant V_2 and 30 kg/ha on variant V_3, comparing them with the V_1 control variant, on which we did not apply any treatment. The polymer was incorporated in spring 2010 on half of the experimental plot (5/10 m - 50 m^2) using disc harrow before sowing and in autumn 2010 and the other half of the experimental plot (5/10 m - 50 m^2), under the autumn plowing after harvesting the prior plants. We analyzed the influence Aquasorb on plant height, leaf chlorophyll content and the production of corn and soybean crops.

Key words: Hydrogel, hydrophilic polymer, Aquasorb

The study aims to introduce in the technology of culture the hydrophilic polymer Aquasorb in order to reduce the gap to the average productivity of the agricultural land in the EU.

Dry periods alternating with periods when heavy rains fall often put agrotechnical problems such as water retention in the soil. One of the technical solutions suitable for solving these problems is to use hydrophilic polymers in agriculture. This solution is one of the ways to exploit water resources efficiently, especially where water consumption is significant quantitative and without alternative solutions for water saving the agricultural production could be jeopardized. The reason for which we test for alternative water saving is represented by the numerous studies showing that The Earth has a limited capacity to produce food, and this limitation in the near future will increased by the continuous reduction of water resources, especially agricultural ones, because farmers have to compete for water with urban residents and industry (Mark W. et al., 2002). Sharma J., 2004 quoted by Gales D. C. et al., 2011, found that plants grown on soil treated with hydrogel had more water available for longer periods of time compared to control groups, which made irrigation frequency to be reduced.

Peterson D., 2009 showed that the hydrogels offer several environmental benefits. Thus, they reduce erosion, reducing sediment and nutrient losses and absorb nutrients to release them gradually, depending on plant requirements. Also they favors bacterial and mycorrhizal colonization of soil. The influence of hydrogels depends on soil structure, the concentration of salts and fertilizers, and the type of plant grown. Highly absorbent polymers with low binding tension between 2 to 4.2 pF, are of great use in agriculture, horticulture and forestry, especially in areas prone to dryness (Johnson M. S., 2006, quoted by Gales D. C. et. al., 2010). Many authors such as Ouchi S. et. al., 1990, Nus J. E., 1992, Smagin A. V. et. Sadovrikova N. B., 1995, Nadlear A. E. et. al., 1996, El-Hady O. A. et. al., 2001, 2002, 2003, showed that processes of germination, plant growth, nutrient acquisition and efficient use of water and fertilizers by plants, increased significantly by mixing sandy soil with hydrogels. The problem of optimal recovery of water, regardless of origin, is one of the major goals of scientific research, because water will become a "cornerstone" of sustainability and the future of mankind (Hera C., 2007 quoted by Gales D. C. et. al., 2011).

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MATERIAL AND METHOD

The experiment began in 2010 and took place in the Didactic Station of "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine, Ezăreni Farm (Moldavian Plain 47° 07'N latitude, 27° 30' E longitude). The experiment was located on a land with a slope of 3-4%, on a cambic chernozem soil type, clay loam, with low acidic pH, medium supplied in N and P_2O_5 and well-stocked in K_2O *(tab. 1).* Average yearly temperature is 9.6 °C and average annual rainfall of about 517.8 mm.

Table 1

Soil chemical properties

Crop	Depth (cm)	pH	Humus %	Nt %	P AL mg/kg	K AL mg/kg
Corn	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

The experience, located on an area of 2400 m^2 is polifactorial, type AxBxC, and is located by the method of storied randomized blocks in three repetitions. The experimental factors are the plant, the polymer dose and the time of administration of the polymer. The analyzed plants are corn, respectively soybean and the polymer doses used are 15 kg/ha Aquasorb for the V_2 version and 30 kg/ha Aquasorb for the variant V_3, which is compared with the control variant V_1 considered witness, which did not receive any treatment. The dosing periods of the polymer are T_1 (polymer embedded in spring 2010 on a half of the area of - 50 m^2- experimental plot using the harrow disc before sowing) and T_2 (polymer embedded under the basic plowing in autumn 2010 on the other half of the experimental plot -50 m^2-). The technology of culture was specific for the analysed crops, respectively corn and soybean. Fertilizers were administered at a dose of 60 kg/ha P_2O_5 + 40 kg/ha N before seedbed preparation and 20 kg/ha N in vegetation in first mechanical weeding for corn, while soybean culture received the entire amount of nitrogen before seedbed preparation. The seedbed was prepared on the day of sowing using the combiner and the seeding was performed with SPC4-FS + U650 for corn and with SPC6 +U650 for soybean culture. There were used hybrids from Pioneer, PR38A24 for corn and PR91M10 for soybean. The chlorophyll content of the leaves was determined using CCM 200 Plus device *(fig. 1).* Measurements were made directly in the experimental field after crop rise, before and after flowering. Plant height was determined using the roulette, after crop rising, in vegetation and before harvesting. The production was determined for each variant, being expressed in kg/ha at STAS moisture. Statistical processing of the experimental data was performed using the analysis of variance and F test.

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

RESULTS AND DISCUSSIONS

Aquasorb is a copolymer of acrylamide and potassium acrylate which belongs to the hydrophilic polymers group *(fig. 2).* They can absorb a significant amount of water which can be released in stages to the plants according to their consumption *(Gales D. C. et al. 2011).*

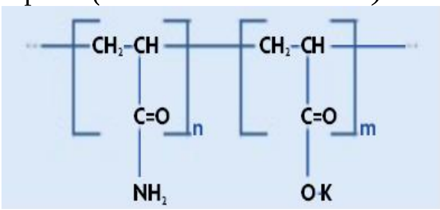

Figure 2 **Structure Aquasorb**

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 with a peak in April and June and beginning with July the drought, was installed, with a peak in September *(tab. 2).* Corn and soybean plants capitalized very well the positive effect of Aquasorb mainly due to lack of rainfall since early august. In dry periods the plants from the treated variants suffered less compared to the plants on control variant which reached earlier the critical threshold. This has contributed significantly to the differences in the average plant height, chlorophyll content of leaves and the yield obtained from the cultures analyzed.

The average height of plants

The average height of the maize plants was positively influenced by the treatment with Aquasorb. Thus, in the variants treated with polymer there were obtained higher plants compared with untreated control variant. The differences statistically assured, were 3.7 cm in V_2T_1, 4.1 cm in V_3T_1, 5.2 cm at V_2T_2 and 5.3 cm at V_3T_2 compared with the control V_1 *(tab. 3).*

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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In *fig. 3* it can be seen that Aquasorb had a positive influence in all phases of corn growing, the biggest difference between the treated and control variants occurring at harvesting (about 8 cm for T_1 and 10 cm for T_2). These differences at harvesting are due to Aquasorb cumulative effect throughout the growing season and to the lack of rainfall since early august. In soybean crop the Aquasorb effect is similar as in the corn crop, resulting in distinct significant differences in the variant V_2T_1 and very significant differences for V_2T_2, V_3T_1 and V_3T_2 variants compared with control variant V_1 *(tab. 3)*. The biggest differences between treated variants and the control witness were obtained at harvest *(fig. 4)*, these differences being due to the cumulative effect of Aquasorb and the favorable climatic conditions at least starting from august.

Leaf chlorophyll content

The leaf chlorophyll content for the analyzed crops was significantly influenced by treatment with Aquasorb. Thus, the plants from the treated variants had more green leaves with a higher chlorophyll content compared to the plants on control variant. In the corn crop there were obtained statistically significant differences between treated and control versions regarding this indicator. Distinct significant differences were obtained for V_2 and V_3 treated variants during polymer T_2 treatment and significant differences for V_3T_1 *(tab. 4)*. Corn plants had greener leaves, so a higher content of chlorophyll in all phases of vegetation in which this parameter was examined (after emergence, before flowering and after flowering), this aspect being shown in *fig. 5-B*. Differences between treated and control variants remained relatively constant in all phases of growth, because the period of drought increased especially in the latter part of July, and until then the plants already capitalized the soil moisture reserves acquired in June when there was 88.2 mm of rainfall, approximately 13 mm above the annual average in the area.

Table 3

The average height of the corn and soybean plants

(average values for vegetation types and phases -2011)

Variant		Plant height for corn				Plant height for soybean			
		cm	% compared to control	Differences (cm)	Significance	cm	% compared to control	Differences (cm)	Significance
V_1 – Control		181,5	100,00	0,00	Mt	65,1	100,00	0,00	Mt
V_2 (15 kg/ha Aquasorb)	T_1	185,2	102,04	3,70	XX	67,0	102,76	1,90	XX
	T_2	186,7	102,87	5,20	XXX	69,0	105,83	3,90	XXX
V_3 (30 kg/ha Aquasorb)	T_1	185,6	102,26	4,10	XXX	68,2	104,60	3,10	XXX
	T_2	186,8	102,92	5,30	XXX	70,2	107,67	5,10	XXX

	T_1	T_2	T_1	T_2
LSD 5 % =	1,9 cm	2,4 cm	0,9 cm	1,1 cm
LSD 1,0 % =	2,7 cm	3,4 cm	1,2 cm	1,6 cm
LSD 0,1 % =	3,9 cm	5,0 cm	1,8 cm	2,3 cm

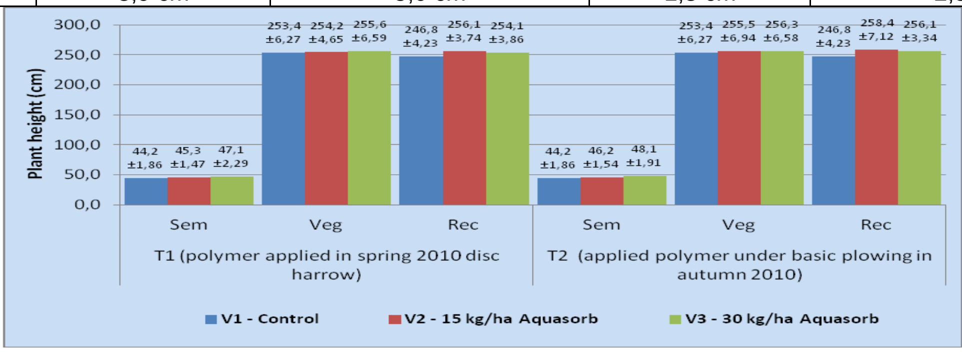


Figure 3 The influence of hydrophilic polymer Aquasorb and the administration period on the average height of corn plants (2011)

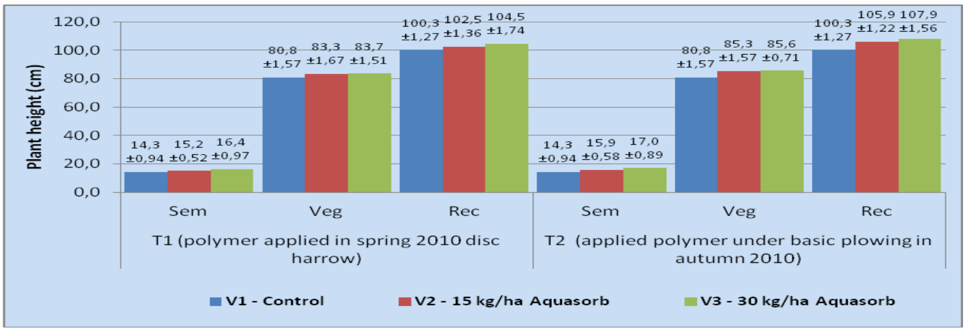


Figure 4 The influence of hydrophilic polymer Aquasorb and the administration period on the average height of soybean plants (2011)

The chlorophyll content was analyzed differently for each floor of the plant, and this aspect is presented in *fig. 5-A*. It can be seen that corn capitalized better the positive influence of Aquasorb especially in the middle floor of the plant, where differences between treated and control variants are greater than in the upper third and lower third. In the bottom third differences are almost imperceptible *(fig. 5-A)*. In the upper third of plants the differences between the variants treated and control variant are approximately 1.9 CCI for polymer T_1 administration period and 3.3 CCI for T_2 polymer administration period. In the median plant floor are recorded the biggest differences, of about 6 CCI both for polymer T_1 and T_2 administration period. The differences are almost unnoticeable for the lower floor being of about 1 CCI for both polymers administration periods. In the soybean crop, Aquasorb has a positive influence on the leaves chlorophyll content, the influence being slightly stronger than for the corn. Thus, between treated and control variants there were obtained differences ranged from 1.8 CCI at V_2T_1 and V_2T_2 to 3.2 CCI at V_3T_2 *(tab. 4)*. The differences were statistically significant. In all phases of vegetation the leaf chlorophyll content differences for variants treated compared with untreated control variant remained relatively constant, with slight variations ranging between 0.9 CCI (T_1) right after culture rise and 3.9 CCI (T_2) in vegetation after flowering *(fig. 6-B)*. Unlike corn, the soybean crop leaf chlorophyll content was influenced on each floor of the plant , the Aquasorb treatment being contributory for obtaining clear differences between V_2 and V_3 treated variants compared with the witness V_1 *(fig. 6-A)*.

Obtained yields

For corn crop, the treatment with Aquasorb hydrophilic polymer led to obtaining statistically significant yield differences between the variants treated with Aquasorb and the control untreated version. Thus, the differences from the control variant V_1 were significant for V_2T_1 variant, distinct significant for V_3T_1 variant and very significant for V_2T_2 and V_3T_2 variants with an yield growth between 285.0 kg/ha for V_2T_1 and 573.6 kg/ha for V_3T_2 *(tab. 5)*. Regarding the soybean crop, the yield was positively influenced by Aquasorb treatment, resulting in statistically significant differences in yield between the variants treated with polymer and the control version. Thus, for T_1 polymer administration period, the yield growth was 69 kg/ha for V_2 variant and 100 kg/ha for V_3 variant. For T_2 polymer administration period we achieved a production increase of 247 kg/ha in V_2 variant and of 283 kg/ha in V_3 variant compared to the control variant V_1, in which we achieved a yield of 3356 kg/ha *(tab. 5)*. There was a period when the precipitation have missed (the second part of the vegetation season), which contributed to obtaining significant differences in terms of yield regarding the corn, respectively soybeans crops. These differences were statistically significant, justifying the use of Aquasorbi in agriculture since the costs of applying the polymer can be recovered even when extreme weather conditions are not met, and even more in a year when the rainfall can be well below the optimal requirements for plants, which would contribute to a much higher yield increases.

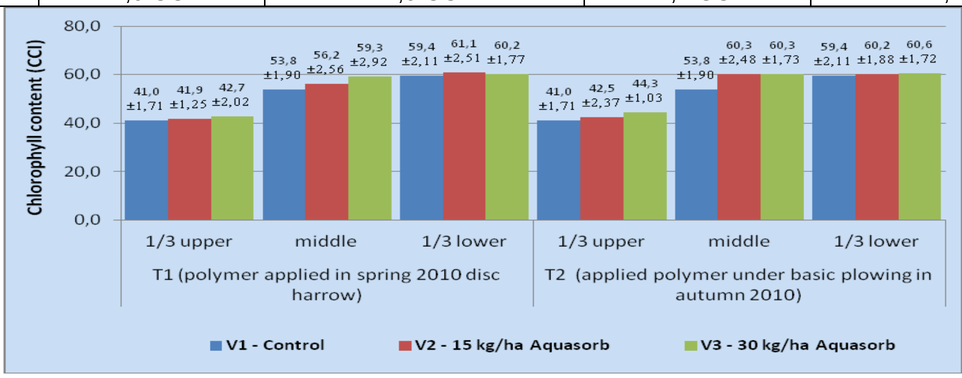
CONCLUSIONS

Aquasorb hydrophilic polymer treatment positively influenced the average plant height, the leaf chlorophyll content and the yield both for corn and soybean crops. Aquasorb has positive influences, especially by the applied dose and less by the administration period (T_1 and T_2), as its effectiveness in soil, which is about five years overlaps several cycles of yield and the arable layer, in which the polymer is incorporated along with basic works is overturned, crushed and mixed so that the administration period effect is especially noticeable in the first year of implementation, in the coming years being noticed the uniformity of the effect on soil horizon (0-30 cm in our case). Due to technical and economical reasons, the dose of 15 kg/ha Aquasorb is considered to be optimal for both corn and soybean crops. Aquasorb hydrophilic polymer has prospects to be used with good results in agriculture, at least in corn and soybean crops, and possibly for other cultures.

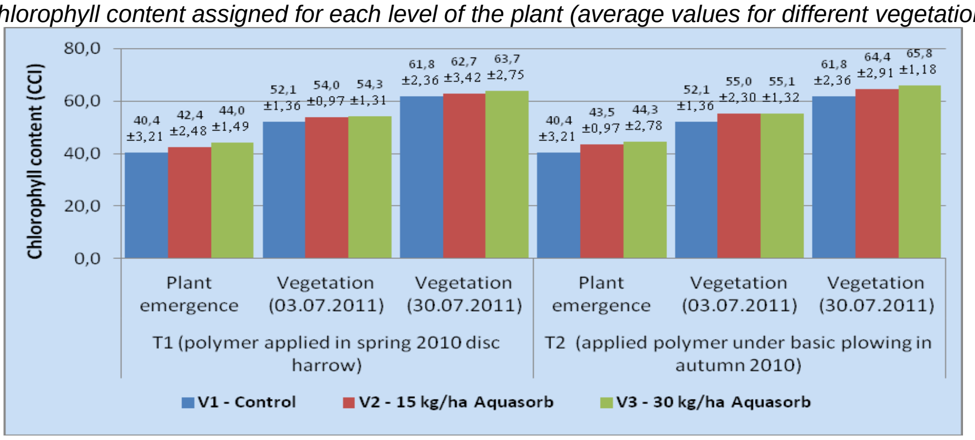
Table 4

Leaf chlorophyll content in corn and soybean crop
(average values per plant and vegetation phases -2011 -)

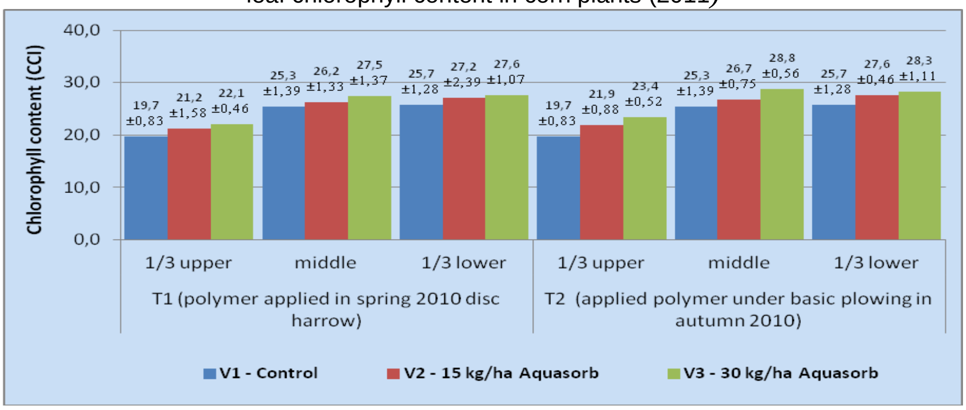
Variant		Chlorophyll content for corn				Chlorophyll content for soybean			
		CCI	% compared to control	Differences (CCI)	Significance	CCI	% compared to control	Differences (CCI)	Significance
V_1 – Control		51,4	100,00	0,00	Mt	23,6	100,00	0,00	Mt
V_2 (15 kg/ha Aquasorb)	T_1	53,0	103,11	1,60		24,9	107,63	1,80	XXX
	T_2	54,3	105,64	2,90	XX	25,4	107,63	1,80	XXX
V_3 (30 kg/ha Aquasorb)	T_1	54,1	105,25	2,70	X	25,7	108,90	2,10	XX
	T_2	55,1	107,20	3,70	XX	26,8	113,56	3,20	XXX
LSD 5 % = LSD 1,0 % = LSD 0,1 % =		T_1		T_2		T_1		T_2	
		1,9 CCI 2,7 CCI 4,0 CCI		1,9 CCI 2,7 CCI 4,0 CCI		1,1 CCI 1,5 CCI 2,2 CCI		0,8 CCI 1,1 CCI 1,7 CCI	



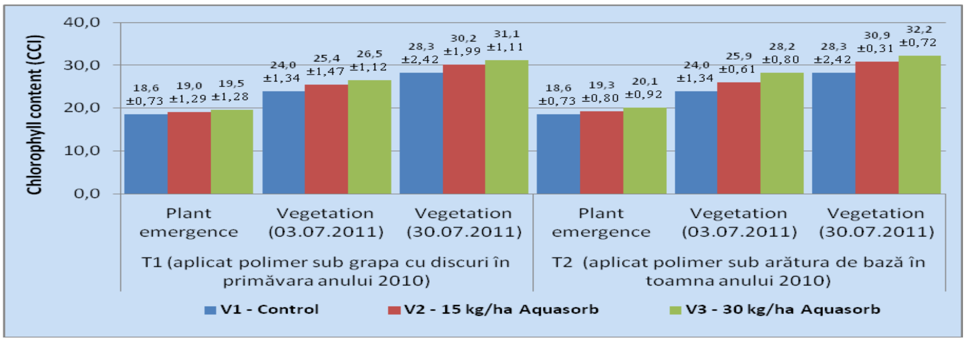
A – Leaf chlorophyll content assigned for each level of the plant (average values for different vegetation phases)



B- The chlorophyll content of the leaves in different vegetation phases (average values per plant)
Figure 5 The influence of hydrophilic polymer Aquasorb and the administration period on leaf chlorophyll content in corn plants (2011)



A – Leaf chlorophyll content assigned for each level of the plant
(average values for different vegetation phases)



B- The chlorophyll content of the leaves in different vegetation phases
(average values per plant)

Figure 6 **The influence of hydrophilic polymer Aquasorb and the administration period on leaf chlorophyll content in soybean plants (2011)**

Table 5

Influence of hydrophilic polymer Aquasorb and the administration period on corn and soybean yield (2011)

Variant		Yield corn				Yield soybean			
		Kg/ha	% compared to control	Differences (kg/ha)	Significance	Kg/ha	% compared to control	Differences (kg/ha)	Significance
V_1 – Control		8615	100	0	Mt	3356	100	0	Mt
V_2 (15 kg/ha Aquasorb)	T_1	8900	103,3	285	X	3425	102,06	69	
	T_2	8922	103,6	307	XXX	3603	107,36	247	XX
V_3 (30 kg/ha Aquasorb)	T_1	9083	105,4	468	XX	3456	102,98	100	X
	T_2	9188	106,7	573	XXX	3639	108,43	283	XXX
		T_1		T_2		T_1		T_2	
LSD 5 % =		240,9 kg/ha		58,8 kg/ha		85,7 kg/ha		134,9 kg/ha	
LSD 1,0 % =		342,5 kg/ha		83,6 kg/ha		121,9 kg/ha		191,7 kg/ha	
LSD 0,1 % =		495,9 kg/ha		121,0 kg/ha		176,5 kg/ha		277,6 kg/ha	

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