THE INFLUENCE OF AQUASORB ON SOIL MOISTURE ON CORN AND SOYBEAN CROPS, IN IASI COUNTY

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Abstract

In Romania, some parts of arable land are affected by degradation processes or are exposed to risk factors such as drought, which occurs on a widespread scale.
In this study we aimed to evaluate the influence of the hydrophilic polymer (Aquasorb) on some soil hydro-physic properties in corn and soybean crops in climatic conditions of the Iasi County. Aquasorb is a copolymer of acrylamide and potassium acrylate, with the property of fixing water and nutrients when incorporated into soil or substrate. This polymer has the ability to gradually release water and nutrients absorbed, so it enables the plant to have continuously available water and nutrients needed for growth and development. Aquasorb works in absorbtion-release water cycles.
The study was conducted in the SDE Didactical and Experimental Station of the University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad" Iasi, Ezăreni farm in 2011. 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 V2 and 30 kg/ha on variant V3, comparing them with the V1 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.
The results showed that Aquasorb positively influenced the soil moisture both in corn and soybean culture, significant differences beeing seen especially before harvesting the plants, due to the drought period previously installed.

Key words: Hydrogel, hydrophilic polymer, Aquasorb, water retention.

The study aims to increase land productivity through the development, testing and implementation of sustainable technologies of plant growth adapted to local pedoclimatic characteristics, using a hydrophilic polymer (Aquasorb). Also we aim to reduce the gap against the average productivity of agricultural land in the European Union. The extent and intensity of extreme weather events reduce agricultural production yearly by at least 30-50%. In Romania, on about 14.7 million hectares of agricultural land, of which 9.4 million hectares of arable land (64% of agricultural area), soils are affected to a greater or less degree by frequent droughts on long periods and in consecutive years, according to NAM.

This is the reason for which we wish to introduce the culture technology of a hydrophilic polymer, by means of which some of the drought effects will be reduced. The general picture of the drought effects, has undergone major changes since the 7th decade of the last century due to the magnification of global climate changes.

In the definition of drought should be mentioned three fundamental characteristics: the absence of rainfall or humidity, the abnormal deficit in relation to statistical values of reference and the prolonged duration of this deficit (Sorocovschi V., 2009). Thus, several types of droughts can be defined: atmospheric drought (meteorological), soil-linked, mixed and hydrologic drought (Minea I., Stângă I. C., 2004).

The problem of optimal capitalization and recovery of water from any source, should be seen as a major goal of scientific research. Water will become the "cornerstone" of sustainability and the future of humanity (Hera C., 2007). One of the ways of effective capitalization of water resources is the use of hydrophilic polymers in agriculture, where water consumption is quantitatively important and without this element the agricultural production may be endangered. Sharma J., 2004, found that plants grown on soils treated with hydrogel had more water available for longer periods of time compared with control groups, which made the irrigation frequency to be reduced.

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Al-Asfoor S.I.M., et al., 2001 showed that Aquasorb applied as a gel has the maximum strength of water retention and absorption at high concentrations of 0.9% and suggested that the maximum concentration that should be applied Aquasorb is 0.6%. Safdar Hayat and Ali Rifat, 2004, showed that in arid and semiarid areas, Aquasorb was proved to be effective in increasing the water retention capacity, reducing the infiltration rate and cumulative evaporation and improving water conservation.

The hydrogel provides a range of environmental benefits. Thus, decreases erosion, reducing sediment and nutrient losses and absorb the nutrients to gradually release them , depending on plant requirements. Hydrogel promotes soil colonization with bacteria and mycorrhiza. The influence of hydrogels depends on soil structure, the concentration of salts and fertilizers, and the type of plant cultivated (D. Peterson, 2009).

MATERIAL AND METHOD

The program 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 %, the draft chernozem soil type, clay-loamy, slightly acid pH, middly supplied in N and P_2O_5 and well stocked in K_2O (table 1).

Multi-annual mean temperature is 9.4 ºC and multi-annual mean rainfall of about 517.8 mm.

Experience is polifactorială, type AxBxC, being located by the randomized storey blocks method in three replications, occupying an area of 2400 m^2. Experimental factors are: plant, polymer dosage and the time of the polymer administration. We administered a dose of of 15 kg/ha Aquasorb in the V_2 variant and 30 kg/ha Aquasorb in the V_3 variant, which are compared with the control variant V_1, which did not received any treatment. The polymer was incorporated in spring 2010 on a half of the experimental plot (5x10 m - 50 m^2) using the harrow disc before sowing (T_1) and in autumn 2010 on the other half of the experimental plot (5x10 m - 50 m^2), under the autumn plowing after the prior plant harvest (T_2).

The culture technology has been specific considering the crop analyzed, namely corn and soybean. Fertilizers were given in a dose of 60 kg/ha P_2O_5 + 40 kg/ha N before the seedbed preparation and 20 kg/ha N in vegetation at first mechanical take, for corn culture; the soybean culture received the entire amount of nitrogen before seedbed preparation. The seedbed was prepared on the day of sowing, using the combinator and the sown was carried out with SPC4-FS + U650 for corn and SPC6 + U650 for soy culture. There were used hybrids from Pioneer company, PR38A24 for corn and PR91M10 for soybean.

To determine soil moisture we used the gravimetric method, as it is known as the most accurate and relatively easy to use, with which are calibrated the instruments and apparatus which determin soil moisture indirectly, such as neutron probes, tensiometers or electrical appliances.

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

RESULTS AND DISCUSSIONS

Aquasorb is a copolymer of acrylamide and potassium acrylate is part of the hydrophilic polymers group. They can absorb a significant amount of water which can be released in stages to the plants according to their consumption.

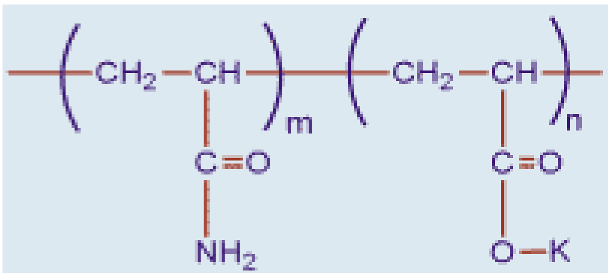

Figure 1 **Structure Aquasorb**

Polyacrylamide improves the soil hydrophysics properties, leading to an increased soil resistance to water and wind erosion and an increased resistance against the destruction of soil structure due to work. It decreases soil pore diameter and also decreases water evaporation which results in increasing soil water availability. Also, there was a decrease in pH and an increase in nitrogen content of sandy soil treated with polyacrylamide (El-Hady et al., 2009).

Polyacrylamides like Aquasorb are not harmful for the environment (Saybold, 1994).

In terms of climate, in the agricultural year 2010 - 2011 there were average monthly values of temperature and medium relative humidity greater than the mean normal values for the area in which we made the study. Regarding to average monthly rainfall, they had a relatively neuniform distribution throughout the period under review, with minimum values recorded in February and September *(*table 2).

Table 2

Weather conditions in 2010-2011

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)
X	7,9	10,1	85	73	46,4	34,4
XI	10,7	4,1	81	78	55,6	34,6
XII	-2,4	-0,8	93	82	34,2	28,9
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	19,4	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	17,0	16,3	62	66	7,2	40,8
Average	10,6	9,6	76,4	70,3	37,1	43,2

**Miroslava Agroexpert Weather Station*

It is interesting to highlight the influence of Aquasorb especially during the drought that was installed in autumn 2011, due to three consecutive months in which rainfall was well below the annual average (VII, VIII, IX), with a minimum recorded in September, just before harvesting. Under these conditions we could observe the hydrophilic polymer influence on maintaining soil moisture at relatively constant and much higher values in V_2 and V_3 variants compared to with variant V_1 (control), which had not any treatment applied. For the corn crop, soil moisture for the entire vegetation season, for the administration time of T_1 polymer (the polymer was embedded under disc harrow in the spring of 2010), showed significant differences at V_2 variant treated with 15 kg/ha Aquasorb and V_3 treated with 30 kg/ha Aquasorb compared with control variant V_1, which was not treated with the polymer. Thus, compared to V_1 (control), the V_3 recorded a soil moisture value higher by 6.2% and V_2 a value higher with 5.6% for the administration time of T_1 polymer *(Table 4).* For the administration time of polymer T_2 (the polymer embedded under the basic plowing in autumn 2010), there were very significant differences in V_2 and V_3 versions compared to V_1 version, considered witness, with an increase in the soil moisture versus V_1 of 6.8% at V_3 and of 6.2% at V_2 *(Table 5).* Between V_3 and V_2 versions, soil moisture values recorded insignificant differences. Throughout all the vegetation season in the variants treated with Aquasorb, V_2 and V_3, we recorded an increase in the amount of soil moisture especially in 15-20 cm soil layer at T_1 and 20-25 cm at T_2, compared with untreated control variant, where the values of soil moisture increase progressively with the depth *(Table 3).*

On the date of sowing in the ground was a high humidity due to rainfalls from April, when there were more than the annual average values, but even in these conditions we obtained higher soil moisture values of the variants treated with polymer versus the untreated control variant, differences provided statistically, both for administration time T_1 and T_2. The same trend was observed during the vegetation season, when the variants treated with polymer, V_2 and V_3, showed distinct differences for the administration time T_1 and very pronounced for the administration period T_2. Thus we obtained of soil moisture values in V_3 and V_2 with 9.9% and 12.1% higher than in V_1, for polymer T_1 time administration , and in V_3T_2 and V_2T_2 with 10.6% and respectively 9.9% higher than in the V_1 variant, considered the control variant (table 3). Before the harvest the same trend was found, and the recorded differences were statistically significant. Soil moisture was higher by 8.5% in V_3T_1 and by 10.0% in V_2T_1 compared with the control variant and at T_2 with 8.5% in V_3 and with 6.2% at V_2 compared to the control (tab.3).

In soybean crop the soil moisture for the entire vegetation season showed very significant differences for both polymer administration time T_1 (the polymer was embedded under disc harrow in the spring of 2010) and T_2 (the polymer embedded under the basic plowing in autumn 2010). Thus, we obtained values of soil moisture higher by 5.9% and 7.9% in V_3T_1 and respectively V_2T_1 than the untreated control variant *(Table 7).* For the polymer administration time T_2 the differences were 7.2% and 7.9% in V_3T_2 and respectively V_2T_2 compared with the untreated control variant (table 8).

Table 3

The influence of Aquasorb on humidity in corn crop

CORN		T_1 (polymer applied in spring 2010 disc harrow)				T_2 (applied polymer under basic plowing in autumn 2010)				Average	
Variant	Depth (cm)	S. 26.05	V. 06.08	V. 18.09	H. 07.10	S. 26.05	V. 06.08	V. 18.09	H. 07.10	T_1	T_2
V_1 (Control)	0-5	14,8	10,6	8,5	7,0	14,8	10,6	8,5	7,0	10,2	10,2
	5-10	20,1	16,3	13,2	11,2	20,1	16,3	13,2	11,2	15,2	15,2
	10-15	20,9	17,3	15,5	14,3	20,9	17,3	15,5	14,3	17,0	17,0
	15-20	23,3	17,5	15,6	14,6	23,3	17,5	15,6	14,6	17,8	17,8
	20-25	23,9	18,0	15,5	15,3	23,9	18,0	15,5	15,3	18,2	18,2
	25-30	24,2	18,1	16,0	15,8	24,2	18,1	16,0	15,8	18,5	18,5
Average	**0-30**	**21,2**	**16,3**	**14,0**	**13,1**	**21,2**	**16,3**	**14,0**	**13,1**	**16,2**	**16,2**
V_2 (15 kg/ha Aquasorb)	0-5	17,4	11,2	11,6	9,6	18,4	10,8	10,6	9,1	12,4	12,2
	5-10	21,0	16,3	15,7	14,2	22,0	16,5	14,6	12,7	16,8	16,5
	10-15	21,8	18,2	**16,3**	14,7	22,3	18,0	16,0	14,3	17,8	17,7
	15-20	**22,8**	**18,5**	16,2	15,5	23,8	**18,5**	16,5	15,1	18,2	18,5
	20-25	22,3	18,1	17,3	15,7	**25,5**	18,3	**17,7**	**15,9**	18,3	**19,3**
	25-30	25,6	18,3	17,4	16,0	24,4	18,9	17,4	15,5	19,3	19,0
Average	**0-30**	**21,8**	**16,8^{X}**	**15,7^{XX}**	**14,3^{XX}**	**22,7^{XX}**	**16,8^{X}**	**15,5^{XXX}**	**13,7^{X}**	**17,1^{XX}**	**17,2^{XXX}**
V_3 (30 kg/ha Aquasorb)	0-5	17,1	11,0	11,7	8,7	15,8	10,8	10,8	9,6	12,1	11,8
	5-10	21,7	16,4	15,5	13,1	21,1	17,3	15,1	12,4	16,7	16,5
	10-15	23,4	17,4	15,8	14,8	22,5	18,3	16,2	14,7	17,9	17,9
	15-20	23,7	17,6	**17,3**	**15,6**	24,9	**18,8**	**17,0**	15,3	18,5	19,0
	20-25	24,3	17,7	15,9	15,6	**25,7**	18,1	17,0	**16,8**	18,4	**19,4**
	25-30	25,3	18,6	16,9	16,5	24,5	18,5	17,2	15,7	19,3	19,0
Average	**0-30**	**22,6^{X}**	**16,4**	**15,5^{XX}**	**14,1^{X}**	**22,4^{X}**	**17,0^{XX}**	**15,6^{XXX}**	**14,1^{XX}**	**17,2^{XX}**	**17,3^{XXX}**
LSD 5 %		1,0	0,4	0,9	0,8	1,0	0,5	0,5	0,7	0,5	0,4
LSD 1 %		1,5	0,5	1,3	1,1	1,4	0,7	0,7	1,0	0,8	0,5
LSD 0,1 %		2,1	0,8	1,9	1,7	2,0	1,0	1,1	1,5	1,1	0,8

Table 4

The influence of Aquasorb on humidity in corn crop T_1
(medium values for the entire vegetation period)

Variant	Humidity (%)	% compared to control	Differences	Significance
V_1 (Control)	16,2	100,0	0,0	Control
V_2 (15 kg/ha Aquasorb)	17,1	105,6	0,9	XX
V_3 (30 kg/ha Aguasorb)	17,2	106,2	1,0	XX

LSD 5% = 0,5% LSD 1% = 0,8% LSD 0,1% = 1,1%

Table 5

The influence of Aquasorb on humidity in corn crop T_2
(medium values for the entire vegetation period)

Variant	Humidity (%)	% compared to control	Differences	Significance
V_1 (Control)	16,2	100,0	0,0	Control
V_2 (15 kg/ha Aquasorb)	17,2	106,2	1,0	XXX
V_3 (30 kg/ha Aguasorb)	17,3	106,8	1,1	XXX

LSD 5% = 0,4% LSD 1% = 0,5% LSD 0,1% = 0,8%

Tabel 6

The influence of Aquasorb on humidity in soybean crop

SOYBEAN		T_1 (polymer applied in spring 2010 disc harrow)				T_2 (applied polymer under basic plowing in autumn 2010)				Average	
Variant	Depth (cm)	S. 30.05	V. 17.08	V. 18.09	H. 07.10	S. 30.05	V. 17.08	V. 18.09	H. 07.10	T_1	T_2
V_1 (Control)	0-5	10,5	14,2	9,7	8,0	10,5	14,2	9,7	8,0	10,6	10,6
	5-10	19,5	14,6	11,4	11,3	19,5	14,6	11,4	11,3	14,2	14,2
	10-15	20,5	15,2	13,8	12,4	20,5	15,2	13,8	12,4	15,5	15,5
	15-20	21,3	15,8	14,0	14,1	21,3	15,8	14,0	14,1	16,3	16,3
	20-25	23,1	16,1	14,2	14,7	23,1	16,1	14,2	14,7	17,0	17,0
	25-30	23,6	16,2	14,3	15,2	23,6	16,2	14,3	15,2	17,3	17,3
Average	**0-30**	**19,8**	**15,3**	**12,9**	**12,6**	**19,8**	**15,3**	**12,9**	**12,6**	**15,1**	**15,1**
V_2 (15 kg/ha Aquasorb)	0-5	12,2	14,8	13,6	8,3	11,3	14,5	13,3	9,1	12,2	12,0
	5-10	21,3	15,0	14,8	12,3	19,8	15,1	14,4	13,3	15,8	15,6
	10-15	22,2	15,8	15,0	13,4	21,2	15,4	14,4	14,2	16,6	16,3
	15-20	**23,7**	**16,4**	15,7	**14,8**	22,4	15,8	15,4	15,0	**17,6**	17,2
	20-25	22,7	16,0	**15,8**	14,6	**25,7**	**16,2**	**15,9**	**15,1**	17,3	**18,2**
	25-30	24,8	16,4	15,7	14,9	25,5	16,2	15,9	15,0	18,0	18,2
Average	**0-30**	**21,2^{XX}**	**15,7^{X}**	**15,1^{XX}**	**13,0**	**21,0^{XX}**	**15,5**	**14,9^{XXX}**	**13,6^{XX}**	**16,3^{XXX}**	**16,3^{XXX}**
V_3 (30 kg/ha Aquasorb)	0-5	12,8	14,8	12,4	9,0	12,1	14,6	13,8	10,1	12,3	12,7
	5-10	20,4	14,9	13,2	11,5	21,0	15,2	14,1	12,6	15,0	15,7
	10-15	21,1	15,5	**14,9**	13,7	21,3	15,7	14,2	13,6	16,3	16,2
	15-20	22,2	**16,4**	14,5	**14,8**	22,3	16,1	15,2	14,7	17,0	17,0
	20-25	**24,6**	15,7	15,3	13,9	**24,2**	**16,5**	**15,8**	**15,7**	17,4	**18,0**
	25-30	24,2	16,0	16,0	15,4	24,2	16,1	15,0	15,5	17,9	17,7
Average	**0-30**	**20,9^{X}**	**15,6**	**14,4^{XXX}**	**13,1**	**20,8^{X}**	**15,7^{XX}**	**14,7^{XX}**	**13,7^{XX}**	**16,0^{XXX}**	**16,2^{XXX}**
LSD 5 %		0,9	0,3	0,8	0,6	0,8	0,2	1,0	0,7	0,4	0,4
LSD 1 %		1,3	0,4	1,2	0,8	1,1	0,3	1,4	0,9	0,6	0,6
LSD 0,1 %		1,9	0,6	1,7	1,2	1,6	0,4	2,0	1,4	0,8	0,9

Table 7

The influence of Aquasorb on humidity in soybean crop T_1
(medium values for the entire vegetation period)

Variant	Humidity (%)	% compared to control	Differences	Significance
V_1 (Control)	15,1	100,00	0,0	Control
V_2 (15 kg/ha Aquasorb)	16,3	107,9	1,2	XXX
V_3 (30 kg/ha Aguasorb)	16,0	105,9	0,9	XXX

LSD 5% = 0,4 LSD 1% = 0,6 LSD 0,1% = 0,8

Table 8

The influence of Aquasorb on humidity in soybean crop T_2
(medium values for the entire vegetation period)

Variant	Humidity (%)	% compared to control	Differences	Significance
V_1 (Control)	15,1	100,00	0,0	Control
V_2 (15 kg/ha Aquasorb)	16,3	107,9	1,2	XXX
V_3 (30 kg/ha Aguasorb)	16,2	107,2	1,1	XXX

LSD 5% = 0,4% LSD 1% = 0,6% LSD 0,1% = 0,9%

Throughout the vegetation season in the variants treated with Aquasorb, V_2 and V_3 we observed an increase in the amount of soil moisture especially in 15-20 cm soil layer at T_1 and in 20-25 cm soil layer at T_2, compared with the untreated control variant, where the amount of moisture increases progressively with soil depth (table 6).

The same trend was observed during the vegetation season, when the variants treated with polymer V_3T_2 and V_2T_1 showed significant differences and the variants V_3T_1 and V_2T_2 showed very pronounced differences (table 6).

Before the harvest the same trend was found for Aquasorb administration time T_2, when there were found significant distinct differences at both V_3 and V_2 versus the control variant but at administration time T_1 differences were not statistically significant. Soil moisture was higher by 8.7% in V_3T_2 and by 7.9% in V_2T_2 compared with the control variant (table 6).

CONCLUSIONS

Following the results, we conclude that the Aquasorb product has perspectives to be used beneficially in Moldavia, for the purpose of efficient capitalization of the water resources through its conservation and gradually release depending on plant requirements.

Also, we noted that at the depth of Aquasorb incorporation the soil moisture was higher, the water being easily extracted from the substrate depth, especially during the periods when drought has been reported.

Aquasorb treated soil variants had a moisture value higher than the untreated control variant, both at sowing and harvest and even during 2011 when the rainfall had an uneven distribution.

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