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THE EFFECT OF THE POLYACRYLAMIDE, POLYVINYLALCOHOL AND CARBOXYMETHYLCELLULOSE ON THE AGGREGATION OF THE SOIL AND ON THE GROWTH OF THE PLANTS

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Abstract. *In this paper we present a report on the effect of the water suspension polymers (polyacrileamide, polyvinylalcohole and carboxymethylcelulose on the aggregation of the soil, as well as, on the growth of the plants such as paprika, petunia and violet. The obtained results show that examined water suspension polymers, in precision concentrations (1ppm, 2ppm, 5ppm), have good effect on the growth and development of paprika, petunia and violet.*

INTRODUCTION

The great number of factors have an impact on the fertility of the soil, such as the constitution, fitosanitary and technological characteristics, etc. The greatest fertility of the soil means its capability to supply humidity and nutritive materials for the plants. Food production demands the use of different kind of the compost, the preparations for the plants protection, irrigation, etc. But, all these have an influence on the price of the agricultural products. In the resent time, there is a growing interest for making an artificial structure in the soil, which can influence through the aero, thermo and water regime in it. It has a positive effect on the yield and quality of crops of different kind of plants. Considered all this, it was interesting to use polymer as artificial structure.

In this paper a few polymer were tested as an artificial structure in the soil sowed by flowers and paprika.

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EXPERIMENTAL

Materials

a) *Polymer*

– polyvinylalcohol K-17
– polyvinylalcohol K-27
– carboxymethylcellulose KMC-Na
– polyacrylamid PAA-N-001
– polyacrylamid PAA-A-001
– polyacrylamid PAA-A-031
– polyacrylamid PAA-A-051
– polyacrylamid PAA-K-011
– polyacrylamid PAA-2900-74

b) *Soil*

Soil of the third class, took from the Bobište (near Leskovac) were used. It is brown, large granular clay with the following constitution:

– large sand 8.1 %
– tiny sand 27.7 %
– clay 39.6 %
– colloid 20.2 %
– humidity 4.4 %

In the superficial layer the pH is the middle acid and the acidity decrease with depth. pH(H_2O) = 6.25 pH(KCl) = 5.2 Hydrolytic acidity Y = 10.10 Humus 4.0 % Nitrogen 0.18%, easy reachable phosphor P_2O_5 3.7 mg, K_2O 21.5 mg (per 100 g H_2O)

c) *Tested plants*

– violets of the same species and genus, with the plant 7 cm height,
– petunias of the same species, with the plant 10 cm height,
– paprika (called white long), with the plant 18 cm height.

Methods

We used our own methods:

a) *Determination of the rate of the sedimentation*

10 mg of the soil was mixed with the polymer solution with the different concentration of 1 ppm, 2 ppm and 5 ppm, considered the soil. The suspension was shacked in a tested tube for 10 times, and the rate of the sedimentation was measured.

b) *Determination of the volume of the sediment of suspension*

After the rate of the sedimentation was measured, the suspension was left at the room temperature. The time of reaching the constant volume of the sediments was measured.

c) *Determination of the water capacity*

The saturated solution was made adding the water into the soil (200 g).

d) The violets were planted on the open area, five of them with polymer and five of them without polymer (control test).

e) The petunias were planted on the vessels, eight of them with polymer and two

control tests.

f) the paprika were planted on the open area, thirty of them with polymer and thirty control tests.

Determination

The following determinations were done:
– the height of the stalk during the growth,
– the number of the leaves, their length and width,
– the number of the leaves and their blooming,
– the number of the blossoms and their diameters,
– the number of the crops and their length,
– the number of the buds,
– the number of the branches,
– the color of the leaves.

RESULTS AND DISCUSSION

We used a nine different water suspension polymers. Due to their functional groups, they can be devided into polyamides, polyalcoholes and polysaccharides. First we determined the volume of sediment made in reaction between different accounts of polymers and sediments made in the reaction. The results are given in Table 1.

Table 1. The increasing of the final volume of the sediments due to concentration of some polymers

Polymer	The increasing of the volume (%) The concentration of the (ppm)		
	1 ppm	2 ppm	5 ppm
K-17	5,7 %	6,5 %	8,1 %
K-24	6,1 %	7,8 %	9,8 %
KMC-Na	4,8 %	6,1 %	7,8 %
PAA-N-001	5,7 %	7,4 %	9,9 %
PAA-A-001	6,5 %	10,0 %	12,8 %
PAA-A-031	7,8 %	10,7 %	13,0 %
PAA-A-051	10,7 %	13,0 %	15,3 %
PAA-K-011	7,4 %	8,3 %	9,9 %
PAA-2900-74	4,3 %	5,7 %	7,4 %
without polymer		3,8 %	

The experiments shows that all used polymers increases the volume of sediment in the soil suspension. The increasing volume is in the function of the increasing concentration.

The highest increase at polymers, describes as A (copolymers of acryleamide and Na-acryle) is in the range of PAA-A-051. This can be correlated with the fact that this polymer has the greatest part of the Na-acryle monomer and due to that the most correct conformation of its macromolecules. This means that the polymer macromolecules react with linear particles in the suspension and create follicle (so called "bridge mechanism").

Macromolecules with more correct conformation take a part in the reaction with the great number of mineral particles. The products are the great follicle and the higher volume of the soil sediments. The polyvinylalcohol and the polysaccharides KMC-Na don't give such a good results as a previous one.

Considered all this, the PAA-A-051 polymer was chosen for the further investigation

The correlation volume of mixture and the time are given in Figure 1. as you can see, the higher concentration of polymer increased the rate of the sedimentation and decreased the volume of mixture. The final time of the sedimentation for some concentration of the polymer is 1 ppm - 50 s, 2 ppm - 135 s and 5 ppm - 125 s. Comparing to this, the final time for the control test is 748 s.

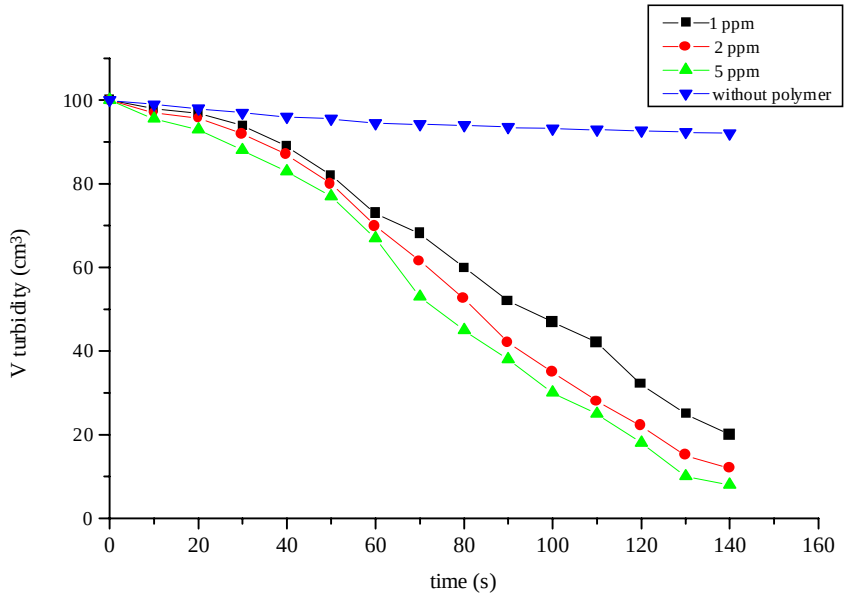

Fig. 1. The dependence between the volume of the turbidity and the time

Different time and increasing volume suggest that the high concentration means the greater follicle but not the littered soil.

Since the PAA-A-051 polymer gave the best results during the aggregation we used it in the following examination.

The violets were planted in the open area. Five of them were watered with 200 ml water containing 2 ppm of polymer, and five of them were watered with pure water (control test). The rate of the growth and the rate of blooming was observed. the results are shown in Table 2 (without polymer) and Table 3 (with polymer). As you can see, the height is greater and the blooming is earlier for 4-5 days in the plants that were watered with polymer. The used polymer also improves aero, water and thermo regime in the soil.

The effect of the polymer to growth of the plants were also observed by planting the petunias into the vessels.

The water capacity for the soil was determined to be 20 ml of the water per 200 g of the soil. The concentration of the polymer-water solution was made to be 2 ppm,

considered soil too. The planted was done at 03.05.1998. The plants were watered with the pure water. The results are shown in Tables 4, 5 and 6.

Table 2. The blooming and the height of the plants violets (without polymer)

The day of the planting	The initial height	Blooming	The height at the day16.05.1998
26.04.1998	7 cm	16.05.1998	12,0 cm
26.04.1998	7 cm	15.05.1998	11,7 cm
26.04.1998	7 cm	17.05.1998	12,2 cm
26.04.1998	7 cm	16.05.1998	12,1 cm
26.04.1998	7 cm	18.05.1998	11,9 cm

Table 3. The blooming and the height of the plants violets (with polymer)

The day of the planting	The initial height	Blooming	The height at the day 16.05.1998
26.04.1998	7 cm	11.05.1998	15,0 cm
26.04.1998	7 cm	12.05.1998	14,7 cm
26.04.1998	7 cm	13.05.1998	14,9 cm
26.04.1998	7 cm	12.05.1998	14,8 cm
26.04.1998	7 cm	13.05.1998	15,0 cm

Table 4. The characteristic of the plants (petunia) due to using polymer (measured 28 days after the planting)

Polymer	The height of the stalk	The length of the leaf	The width of the leaf	The diameter of the leaf	The color of the leaf
K-17	24 cm	3,5 cm	2,4 cm	5,5 cm	light green
K-24	22 cm	4,0 cm	2,5 cm	6,0 cm	green
KMC-Na	27 cm	3,5 cm	2,0 cm	4,5 cm	green
PAA-N-001	22 cm	3,8 cm	2,3 cm	5,5 cm	dark green
PAA-A-001	28 cm	4,5 cm	2,0 cm	5,0 cm	dark green
PAA-A-031	20 cm	3,7 cm	2,6 cm	5,8 cm	dark green
PAA-A-051	21 cm	4,0 cm	2,8 cm	5,9 cm	dark green
PAA-K-011	25 cm	3,5 cm	2,1 cm	5,1 cm	dark green
PAA-2900-74	28 cm	3,6 cm	2,4 cm	5,4 cm	green
without polymer	28 cm	3,5 cm	2,0 cm	4,5 cm	light green
without polymer	27 cm	3,4 cm	1,9 cm	4,4 cm	light green

Table 5. The characteristic of the plants (petunia) due to using polymer (measured 38 days after the planting)

Polymer	The number of the blossoms	The number of the buds	The height of the stalk	The number of the leaves	The length of the leaves	The width of the leaves	The diameter of the blossoms	The color of the leaves
K-17	1+1 bloom.	2	32,0 cm	24	3,7 cm	2,5 cm	5,5 cm	green
K-24	2+1	3	29,0 cm	27	5,5 cm	2,6 cm	5,5 cm	dark green
KMC-Na	2	3	32,7 cm	29	3,6 cm	2,3 cm	5,1 cm	green
PAA-N-001	1+1	3	35,0 cm	26	4,8 cm	2,2 cm	5,2 cm	dark green
PAA-A-031	2+2	3	26,0 cm	40	4,3 cm	2,8 cm	5,8 cm	dark green
PAA-A-051	3+2	4	27,5 cm	43	4,5 cm	3,0 cm	6,0 cm	dark green
PAA-K-011	1+1	2	30,0 cm	26	3,9 cm	2,4 cm	4,2 cm	green
PAA-2900-7	2+1	3	29,5 cm	25	3,8 cm	2,5 cm	5,0 cm	green
without poly.	1+1	2	38,0 cm	23	2,5 cm	2,0 cm	4,0 cm	light green

Table 6. The characteristic of the plants (petunia) due to using polymer (measured 104 days after the planting)

Polymer	The number of the blossoms	The number of the buds	The height of the stalk	The number of the leaves	The length of the leaves	The width of the leaves	The diameter of the blossoms	The color of the leaves
K-17	0+23	3	46,0 cm	60	4,0 cm	2,7 cm	0 cm	light green
K-24	1+33	2	60,0 cm	62	6,0 cm	2,7 cm	5,0 cm	light green
KMC-Na	0+28	1	51,0 cm	64	5,0 cm	2,3 cm	0 cm	light green
PAA-N-001	2+28	3	63,0 cm	60	4,6 cm	2,5 cm	4,7 cm	light green
PAA-A-001	1+19	1	56,0 cm	61	5,1 cm	2,2 cm	4,5 cm	light green
PAA-A-031	2+30	2	48,0 cm	71	4,6 cm	2,8 cm	4,8 cm	green
PAA-A-051	2+35	2	50,0 cm	78	4,4 cm	3,1 cm	5,0 cm	green
PAA-K-011	1+30	2	46,0 cm	61	4,0 cm	2,5 cm	4,3 cm	light green
PAA-2900-74	1+17	0	50,0 cm	58	5,0 cm	2,5 cm	4,5 cm	light green
without poly.	1+21	3	78,0 cm	44	3,5 cm	2,2 cm	4,0 cm	light green

17 days after the planted was done, the first blooming was noticed to be in the soil mixed with the PAA-A-051 polymer. Two days later, the plants that were planted in the soil with KMC-Na polymer were also obtained. At last, 23 days later the other plants that were planted in the pure soil were bloomed.

At 31.05.1998, we have done following measurements:

– the height of the stalk,
– the length of the leaf,
– the greatest width of the leave,
– the diameter of the blossom and
– the color of the leaf.

The results (Table 4) showed that the plants without polymer have small blossoms and light-green leaves. The plants with polymer have bigger blossoms and dark-green leaves.

The comparation of the roots of the plants were done at 30.09.1998. The roots are bigger and branches at the plants with polymer. This means, these roots can better supply plants with mineral materials.

In Table 5 are the results obtained at 10.06.1998. The plants with polymer have better growth then plants without polymer. This can be notices through increased number of blossoms, buds, the dimension and the color of the leaves. the control tested plants only have higher height, but not such a good fertility. The results in Table 6 (obtained at 15.08.1998) showed that polymers have positive effect on the growth of the plants, especially PAA-A-051.

Table 7. The characteristics of the paprika (repeated 3 times) with PAA-A-051 polymer (5 ppm) (measured 38 days after the planting)

Polymer	The number of the leaves	The height of the stalk	The number of the crops	The number of the branches	The color of the leaves	The number of the blossoms	The length of the crops
PAA-A-051	18	26	1	6	green	4	6 cm
PAA-A-051	17	24	1	7	dark green	5	7 cm
PAA-A-051	19	26	1	7	green	4	6 cm
without poly.	16	22	–	5	green	4	–
without poly.	17	23	1	6	light green	3	5 cm
without poly.	15	22	–	6	green	3	–

Comparation between PAA-A-051 polymer and the control tests are given in Table 7 and 8. In all experiments the results at examples with polymers are better than control. The results showed the increase of dimensions and the number of crops and that polymer have better quantity and quality than control.

Table 8. The characteristics of the paprika (repeated 3 times) with PAA-A-051 polymer (5 ppm) (measured 104 days after the planting)

Polymer	The number of the leaves	The height of the stalk	The number of the crops	The number of the branches	The color of the leaves	The number of the blossoms	The length of the crops
PAA-A-051	36	35 cm	6	10	dark green.	2	16 cm
PAA-A-051	35	38 cm	6	11	dark green	1	17 cm
PAA-A-051	34	38 cm	6	12	dark green	2	16 cm
without poly.	28	37 cm	4	9	green	1	13 cm
without poly.	30	35 cm	5	10	dark green	–	14 cm
without poly.	31	37 cm	5	11	green	1	14 cm

CONCLUSION

The usage of water suspension polymer as an artificial component of soil, gives the possibility to improve the quality of agricultural products, and to increase the economy. The results depend on the nature of the polymer and its quantity.

We presume that the polymer macromolecules react with linear particles in the suspension and create follicle (so called "bridge mechanism"). This means that the polymer improves the aero, thermo and water regime of the soil, and has the positive effect on the yield and littered of the crops. The best characteristics posses the polymer containing alkyd and carboxyl groups, especially PA-A-051 polymer.

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UTICAJ POLIAKRILAMIDA, POLIVINIL ALKOHOLA I KARBOKSIMETIL CELULOZE NA AGREGACIJU ZEMLJIŠTA I NJIHOV ODRAZ NA RAZVOJ BILJAKA

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U radu je ispitivan uticaj polimera suspendovanih u vodi (poliakrilamid, polivinil alkohol i karboksimetilceluloza) na agregaciju zemljišta i njihov uticaj na rast i razvoj biljaka: paprike, petunije i ljubičica. Na osnovu dobijenih rezultata konstatovano je da ispitivani polimeri suspendovani u vodi u odredjenoj koncentraciji (1ppm, 2ppm, 5ppm) povoljno utiču na rast i razvoj paprike, petunije i ljubičice.