RESEARCH ON THE INFLUENCE OF HYDROGELS STOCKOSORB AND TERRACOTTEM ON THE DEVELOPMENT OF SOME AGRICULTURAL PLANTS SPECIES

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Abstract:

Amplification of the greenhouase effect has increased the conditions of abiotic stress on plant growth, mainly by eroding large areas of land and reducing freshwater reserves. A remedy for increasing the efficiency of these lands and decreasing the irrigation is the incorporation in their structure of ecological and biodegradable hydrogels. Hydrogels are hightly flexible, inflatable materials composed of polymers which have the property of absorbing and retaining a large amount of water, subsequently releasing them into several absortion–release cycles. By their specific characteristics, they can lead to : stimulating water retention capacity near seeds or roots, reducing the risk of water loss by leaching or evaporation, increasing soil permeability, reducing soil degradation and implicitly increasing quantitative and qualitative productivity. Due to these properties, hydrogels are finding a growing number of applications in both agriculture and horticulture, by being very useful in conditioning and fertilizing soils and by also having a stimulating effect on : the proper growth of agricultural plants, the physiological processes and development .
Based on these observations, the influence of 2 types of hydrogels was observed, namely: Stockosorb and TerraCottem on the state of these types of vegetation: wheat, maize and sunflower. The result of this research has shown a increased influence and efficiency of about 11%- 16% on the chosen plants that are treated with Terracotem compared to that of Stockosorb.

Key words: Hydrogel, Stockosorb,TerraCottem, hydrophilic polymer, water retention

In the last decades, the drought and related phenomena, such as aridization and desertification, represent, after pollution, the second major problem faced by mankind.

Agriculture is based on the existence of a sustainable and renewable resource base such as water and soil. For this purpose, new specialists develop new methods of irrigated land protection and the most efficient use of water resources. The relationship between plant genetics, water consumption, practices used and local environmental conditions is the quantitative and qualitative basis of production.

The hydrogel polymer compound seems to be extremely effective to be used as a soil conditioner in agricultural sector, to boost crop tolerance and growth in a sandy or lightweight gravel substrate. The hydrogel polymer has been established as a soil conditioner to reduce soil water loss and increase crop yield.(Ovalesha M.A. *et al*, 2017).

Hydrogel polymers have the ability to absorb water and increase their original weight a hundred times within a short period of time and desorb the absorbed water under stress condition. (Zhang J. *et al*, 2006). Thus, the hydrogel increases efficient water consumption, decreasing irrigation costs and increasing irrigation intervals, also implements the soil's water holding capacity and soil porosity, providing plants with eventual moisture and nutrients as well as enhancing plant viability and ventilation and root development which provides a conducive atmosphere for better growth of plants and finally increases crop yield.

Applications of hydrogels are closely related to soil type, geographical area, and plant species.

Thus, this paper aims to test two categories of polyacrylamide hydrogels such as Stockosorb and Terracottem to track the influence and their effectiveness on the state of vegetation in agricultural plants like: wheat, maize and sunflower. For these crops the next hybrids are used: Mirastar, PO412 and Justin.

TerraCottem Complement (*figure 1*) has been specially formulated for applications in agriculture. This replenishes the soil components that have been consumed by the plants during the growing season. Due to its application of nutrient

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and water holding capacity of soils and growing medium is kept in optimal conditions. In its composition the following components that stimulate the growth of plants are included: *1. growth precursors* that activate the elongation and differentiation of the cells in the root and lead to leaf development and an increase in biomass production - roots thus grow faster at greater depths; 2. *acrylamide* cross-linked polymers of acrylamide and acrylic acid neutralized by potassium and ammonium salts absorb and store water that is normally lost at evaporation, reducing the volume and frequency of irrigation need by up to 50% (Tirthankar J. *et al*, 2001). This water is then kept at the disposal of the plant that accesses the water accumulated as needed by the root wires, keeping the water in the root area for a longer period of time; 3. *fertilizers* provide balanced plant nutrition based on macro and microelements.

Figure 1 **Structure of TerraCottem**

TerraCottem's carrier materials are selected for their chemo-physical properties (CEC, WRC, etc.) and their characteristics which allow homogeneous distribution of all components.

The Stockosorb (*figure 2*) is a soil conditioner specially designed and developed for water and nutrient retention and release in substrates and soils. Upon contact with water, it swells quickly, creating a hydrogel by Stockosorb absorbing and retaining large quantities of plant available water. Fertilizer leaching can thus be reduced. During the soil drying process, both water and water-soluble nutrients are released to the plant in a uniform manner.

Figure 2 **Structure of hydrogel Stockosorb**

Is a highly cross-linked water insoluble superabsorbent anionic polymer that is partially neutralized with potassium. Stockosorb 500 is a copolymer containing acrylic acid, acrylamide and potassium and Stockosorb 660 is a homo-polymer based on acrylic acid potassium. This hydrogel absorbing more than 216 times its original weight in water, and then releases it on demand from plants. Stockosorb also binds and releases water-soluble nutrients, creating a healthy micro-environment.

Stockosorb also strongly resists soil pressure at high soil depth without losing its swelling capacity. Performs its wetting/drying cycles over a long period of time, maintaining its very high water swelling and releasing capacity even against soil pressure.

MATERIAL AND METHOD

The experiments were performed in the field conditions on 8 experimental plots with 1 m^2 each, in which 3 variants were placed: V1 (control untreated –without treatment), V2 (treated with 20 kg/ha Stockosorb) and V3 (treated with 20 kg/ha TerraCottem). The seeds were planted at.1.04.2019.

Inflation of hydrogels was followed using facilities designed on the principle of operation of the Dogatkin apparatus. The burial of the hydrogels in the soil was made at a depth of 8-15 cm. The soil used had an average organic content of 71.25% and nutrients (values reported relative to the dry substance): $N\text{-}NO_3 = 4.35 \bullet 10^{-3}$ %, $N\text{-}NH_4 = 1.85 \bullet 10^{-3}$ %, $P_2O_5 = 1.45 \bullet 10^{-3}$ %, $K_2O = 34.25 \bullet 10^{-3}$ %, $CaO = 117 \bullet 10^{-3}$ %, $MgO = 42.35 \bullet 10^{-3}$ %. The cultivated agricultural plants are: wheat (*Triticum aestivum*), maize (*Zea mays*) and sunflower (*Helianthus annuus*).

The vegetation state of plants grown in the soil-hydrogel mix compared to the control sample (plants grown on the same soil type but without a hydrogel) have been observed for 4-6 months, depending on their vegetation period. After this time, the plants were removed and then measured and weighed.

RESULTS AND DISCUSSIONS

Plant growth observations were made throughout their vegetation period between April and September 2019. It was found that plants placed on the hydrogel-embedded lots developed better than the control plants on the non-hydrogel plot. There were differences in height, number of leaves, seeds, and beans differences due to a better nutrition regime for plants tested on hydrogel lots. Although water quantities and watering ranges were the same for all plants, the presence of hydrogels in the soil determined that retained water, at a higher proportion and longer intervals, would help to improve the growth of plants on these lots compared to the blank without hydrogels.

The evolution of plants is influenced by both the swelling behavior of the hydrogels and the nature of the polymer included. The average height of plants is directly proportional to soil moisture. There are statistically significant differences between the treated variants with hydrogels and the witness variant. Therefore, the sizes of the plants were higher in plants treated with hydrogels TerraCottem and Stockosorb.

In the study period, the plants of the TerraCottem hydrogel group were best developed (because includes more nutrients), then those on the Stockosorb which did not allow the development of spectacular plants, even if the conditions were the same. It also has a higher water retention capacity of about 13% compared to Stockosorb hydrogel.

Table 1

Evolution of the start of vegetation and ripening for the 3 species of plants

Agricultural Plants	Date of vegetation start (emergence)			Date of ripening start		
	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem (V3)	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem (V3)
wheat	09.04.2019	08.04.2019	06.04.2019	04.07.2019	27.06.2019	22.06.2019
maize	07.04.2019	06.04.2019	05.04.2019	13.09.2019	03.09.2019	27.08.2019
sunflower	15.04.2019	12.04.2019	10.04.2019	06.08.2019	24.07.2019	15.07.2019

In table 1 it is observed for wheat culture: begins to rise around 9.04.2019 on the control lot (V1), on 8.04.2019 on the lot with Stockosorb and around 6.04.2019 for the TerraCottem lot and dates of ripening start are: around 4.07.2019 for (V1), 27.06.2019 for (V2) and 22.06.2019 (V3).

The next culture, as the moment of emergence, is represented by maize, around 15.04.2019 on the witness lot, on 12.04.2019 the lot with Stockosorb and around 10.04.2019 for the TerraCottem lot, and dates of ripening start are: around 13.09.2019, 3.09.2019 for (V2) and 27.08.2019 (V3). For the sunflower culture, as the moment of emergence begins around 15.04.2019 on the witness lot, on 12.04.2019 the lot with Stockosorb and around 10.04.2019 for the TerraCottem lot, and dates of ripening start are: around 6.08.2019, 24.07.2019 for (V2) and 15.07.2019 (V3).

The most covenient are the variants with TerraCottem and Stockosorb. During the vegetation, the observations and determinations were achieved for: sunrise, flowering, maturity and density of the selected crop. In figure 3 is represented the development of wheat culture in the year of study 2019.

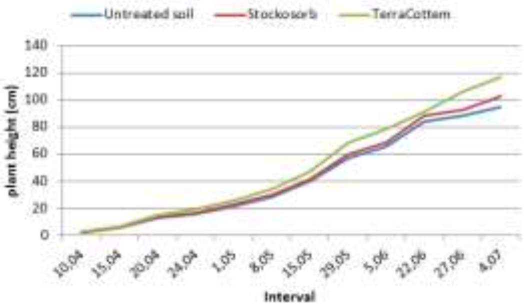

Figure 3 **The development of the wheat culture in the year of study 2019**

For wheat culture, the maximum height is reached on 4.07.2019, a maximum of 116.9 cm in the presence of TerraCottem, 102.5 cm the one treated with Stockosorb and 95.2 cm on the control lot. Table no.2 shows the characteristics of wheat culture. The raw protein content had values of between 13.7 % for the control lot and 14.50% for the lot with TerraCottem, and the maximum production was 7087 kg/ha.

Table 2

Characteristics of wheat culture

Characteres	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem(V3)
Production (kg/ha)	6125	6650	7087
Mass of 1000 seeds (g)	41	45	49
Hectolitre mass kg/hl	72	74	79
Raw Protein %	13.7	14.10	14.50

In figure 4 is represented the development of the maize culture in the year of study 2019.

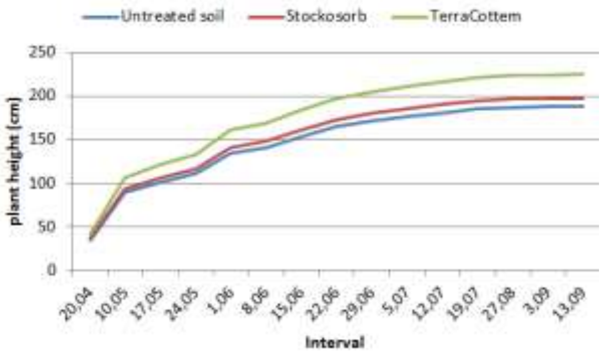

Figure 4 **The development of the maize culture in the year of study 2019**

For maize culture, the maximum height is reached on 13.09.2019, a maximum of 225.3 cm in the presence of TerraCottem, 197.6 cm the one treated with Stockosorb and 188.2 cm on the control lot. In *table 3* it is observed the characteristics of maize culture. For experiments on the lot with TerraCottem have obtained very favorable values for: production -16045 kg/ha, starch content -93.73% and protein content -9.61 (g/100 g dry substance).

Table 3

Characteristics of maize culture

Characteres	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem(V3)
Production(kg/ha)	15 150	15 650	16 045
Starch content (%)	75.78	86.85	93.73
Protein content (g/100gdry sub)	8.93	9.42	9.61

In *figure 5* is represented the development of the sunflower culture in the year of study 2019.

For sunflower culture, the maximum height is reached on 6.08.2019, a maximum of 201.6 cm in the presence of TerraCottem, 176.8 cm the one treated with Stockosorb and 168.4 cm on the control lot.

Average values of sunflower seed production and morphophysiological characters tested are summarized in *table 4*.

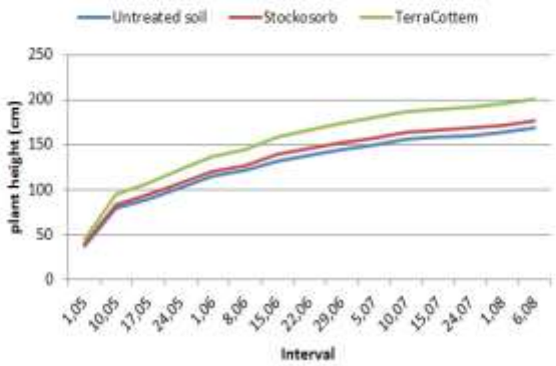

Figure 5 **The development of the sunflower culture in the year of study 2019**

From the values mentioned above, the advantages of incorporating the Teracottem into the soil are obvious, which helps: obtaining a seed production of about 3560 kg/ha, developing a diameter calatidium of up to 36.15 cm, oil content in seeds higher than 57.8% or a percentage of dry seeds of only 2.1%..

Table 4

Average values of sunflower seed production and morphophysiological characters tested

Characteres	Control lot (V1)	Lot with Stockosorb (V2)	Lot with Terra Cottem (V3)
Seed production (kg/ha)	2980	3240	3560
Weigh of seeds per calatidium (g)	149.15	161.32	178.22
Percent dry seeds (%)	3.8	3.2	2.1
Mass of 1000 seeds (g)	74	81	89
Hectolitric mass	36	37.5	39
Oil content in seeds (%)	51.8	54.6	57.8
Number of days from sowing/ physiological maturity	128	127	125
Heigh of the plants (cm)	168.4	176.8	201.6
Thicknees of the stem (cm) -1 m from the ground	2.8	3.2	3.9
Diameter calatidium (cm)	30.35	32.75	36.15
Efficiency of the leaf surface (mg dry subst/cm^2)	1.45	1.61	1.74

CONCLUSIONS

The characteristics of hydrogels influence the development of plants by swelling water holding capacity in soil, it also provides a conducive atmosphere for the better growth of roots.

It is found that in the presence of TerraCottem the plants germinate and grow faster compared to the Stockosorb hydrogel and the control group without hydrogels.

The production of plants on the experimental lot with Teracottem is about 13% higher compared to the one on the Stockosorb hydrogel lot and about 20% higher than on the control lot.

Future research take into consideration the application of polymers in different agro-ecological conditions, soil types, as well as the prolonged effect of the polymer on subsequent rotational crops.

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