RESULTS REGARDING THE FERTILIZATION OF THE SUNFLOWER CROP WITH AN EFFLUENT OBTAINED BY WASTEWATER TREATMENT

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Keywords: energy plant, sand, wastewater, productivity, quality

ABSTRACT

The research was carried out in 2020 on the sunflower crop grown in sandy soils in southern Oltenia and aimed at the influence of fertigation with an effluent obtained by wastewater treatment, compared to conventional fertilization and irrigation with normal water from surface water sources. The obtained results showed the positive influence, on the nutritional status of the plant, of ensuring the dose of nitrogen in the vegetation by fertigation with purified water, applied fractionally in 2-3 steps (Nt-3.5%; Pt = 0.35% Kt = 2.7%), compared to classical fertilization and irrigation with normal water from surface water sources. It was noted with the best results on production (4427.5 kg / ha) and the weight of one thousand grains (69 g), the variant in which the dose of 70 kg N / ha, required in vegetation, was ensured by irrigation with treated water, applied fractionally in two doses of 50%, starting with the phase of 5-7 leaves.

INTRODUCTION

Water supply and degradation of water quality are global concerns, which will intensify with increasing water demand, unexpected effects of extreme events and climate change. Water quality is characterized by the set of physical, chemical, biological and bacteriological properties, expressed quantified, which allow water to fall into a certain category and have the property of being able to be used for a certain purpose (Newman, P.J., 1988). For this reason, globally marginal quality water will become an increasingly important component of water supply in agriculture, especially in countries with water shortages (Qadir et al., 2007). Also, the basic directions and methodologies for environmental control and surveillance have been developed, which include those related to water quality assessment (Uttomark, P., Wall, P., 1975). In the field of wastewater treatment, in recent years numerous theoretical and applied researches have been carried out and a rigorous control has been established regarding the content of nutrients in wastewater. Specialists' attention has been paid to non-metals, organic compounds, halogenated compounds, insecticides, pesticides and herbicides, as well as volatile organic compounds (Ionescu Gh. C., 2010, Van Nieuwenhujzen, A., & Van der Graef., 2011). Industrial wastewater treatment is a complex process, through which impurities (pollutants) in water are separated from the water mass in order to restore the physico-chemical properties of water before use. The phenomenon of water pollution is any change in the composition or quality of water, so that water becomes more or less suitable for use (Zărnoianu, 2019). Wastewater contains the main plant nutrients (NPK) and also trace elements. Nutrients from treated municipal wastewater provide a fertilizing value for crop production, but in some cases are in excess of plant needs and cause problems related to excessive vegetative growth, delayed or uneven maturity or low quality. Nutrients that are naturally present in wastewater can save on fertilizer costs, thus ensuring a cycle of environmentally friendly nutrients

(Drechsel, P., et al., 2010). Research to study the impact of wastewater on sunflower production elements has concluded that treated wastewater can be successfully used in sunflower cultivation (Maria Sakellariou Makrantonaki et al. 2011, Hamzeh Rawashdeh, 2017 and Michalis Chatzakis et al. 2011).

MATERIAL AND METHOD

The research was carried out in 2020 on the sunflower crop grown in sandy soils in southern Oltenia and aimed at the influence of fertigation with an effluent obtained by wastewater treatment, compared to classical fertilization and irrigation with normal water from surface water sources. The treated water was obtained by the National Research-Development Institute for Environmental Protection, Bucharest, with the help of a wastewater treatment plant, within the complex project 27PCCDI / 2018, in order to use them for fertigation of energy crops, quality parameters being restored in table 1. The experiment was performed in vegetation vessels, filled with sand with low natural fertility, having a low total nitrogen content (0.044% -0.085%) and a medium supply of extractable phosphorus (27-35 ppm) and exchangeable potassium (45-80 ppm). When filling the pots with sand, it was fertilized with complex fertilizers type N15P15K15, in a dose of N80P80K80. This dose was applied in the form of a complex fertilizer of type 15-15-15 in the preparation of the soil mixture, in a dose of 3.2 g to the vessel with an area of 0.06154 m^2.

Table 1

The quality of the water used to irrigate the sunflower plant

No.	Quality indicators	Value of Quality Indicators	
		Purified water	Normal water
1	$N\text{-}NH_4$	189 mg/l	0,06 mg/l
2	$N\text{-}NO_2$	0,05 mg/l	0
3	$N\text{-}NO_3$	8,2 mg/l	0,61 mg/l
4	P total	0,9 mg/l	0
5	Aluminiu	3 mg/l	0
6	Ca	19,6 mg/l	73,4 mg/l
7	Mg	31,1 mg/l	44,5 mg/l
8	Na	226,1 mg/l	22 mg/l
9	HCO_3	1156 mg/l	400 mg/l
10	CO_3	72 mg/l	0
11	Cloruri	264 mg/l	25,5 mg/l
12	Conductivitate	3,5 mS/cm	0,57 mS/cm
13	K	150 mg/l	0
14	CBO_5	100 mg/l	0
15	Sulfați	176 mg/l	30

The following were studied:

- two variants of irrigation with water from the street network (V1 = N80P80K80; V2 = N150P80K80, the dose of N70 being applied in vegetation, in the phenophase of 5-7 leaves of the plant, in the form of ammonium nitrate, in a dose of 1.3 g vessel, representing 0.43078 g nitrogen active substance / vessel).

- four variants of application of irrigation with the effluent obtained by wastewater treatment (total nitrogen content of 221 mg / l), which ensured the dose of N70 in vegetation on the

agrofound of N80P80K80 (V3 = nitrogen from purified water, applied in fractions, in 4 doses of 25%), V4 = nitrogen from purified water, applied in fractions, in 3 doses of 33%), V5 = nitrogen from purified water, applied in fractions, in 2 doses of 50%) and V6 = nitrogen from treated water, applied in a single dose of 100%). The 100% dose was applied in the phase of 5-7 leaves of the plant, and the other doses were applied weekly, until the flowering of the plant. During the vegetation period of the plant, morphological, biometric, quality and productivity determinations were performed. From a physiological point of view, in the flowering phase of the plant, the following were analyzed: the diurnal variation of the foliar photosynthesis, the water forms and the dry matter from the leaves, the index of the foliar surface. At harvest it was determined: grain yield in calatidium, grain production and weight of one thousand grains. The obtained results were analyzed and interpreted by analysis of variance (ANOVA) and with the help of mathematical functions.

RESULTS AND DISCUSSIONS

The biometric determinations, regarding the growth and development of the sunflower plants, showed a diameter of the calatidium between 14.5-16 cm and an index of the leaf surface with values of 5-6.7, with maximums at the fertilized with N80P80K80, to preparing the germination bed + N70 - in vegetation, by fertigation with purified water, applied fractionally in doses of 50% + 50% (23.45 mm). There was a positive distinctly significant correlation between leaf surface index and calatidium diameter, similar results were found in studies by Mudassar Iqbal et al, 2013, which show that the leaf surface index induced a positive contribution on calatidium diameter (Figure 1).

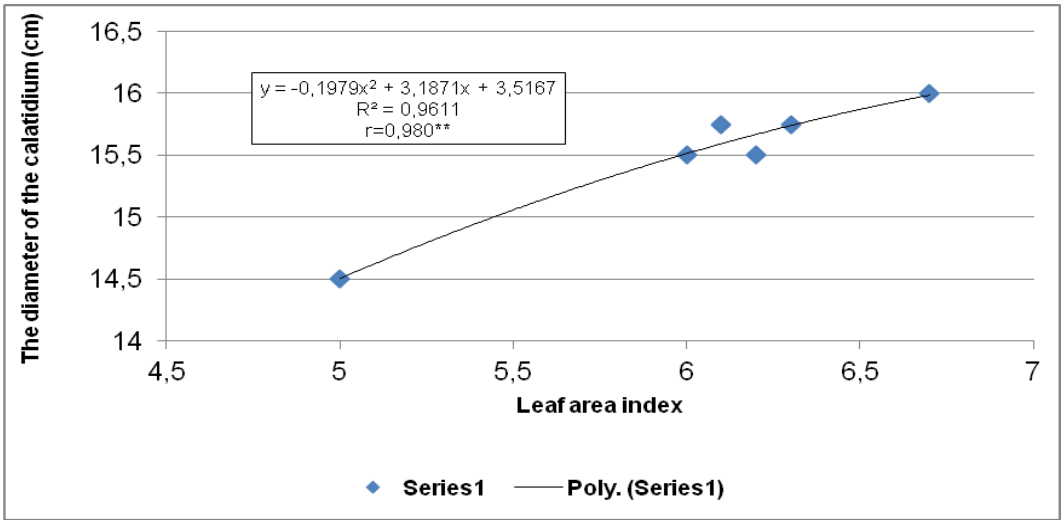

Figure 1. Correlation between the index of the leaf surface and the diameter of the calatidium of the sunflower plant

During the flowering phase of the plant, was determined the diurnal variation of the photosynthesis process, in the climatic conditions registered at the level of the observation camera of the LC Pro + device. The analysis of the values recorded by the active radiation in photosynthesis and the temperature at the level of the foliar apparatus, underlines significant differences during the day, which had a decisive role in the development of the physiological processes of the plant (Table 2). In sunflower, the diurnal variation of photosynthesis showed a unimodal curve, with the maximum values recorded at noon in all variants analyzed (Figure 2). Fertilization with purified water applied in 2-3 stages led to the maximum

accumulation of CO_2 through the process of photosynthesis (15.33-15.52 µmol CO_2 / m^2 / s).

Table 2

Climatic conditions at the time of physiological determinations

Time of day	Active solar radiation in photosynthesis (µmol/m^2/s)	Temperature (°C)	Atmospheric pressure (hPa)
9 o'clock	800-870	24-26	1011
12 o'clock	1444 – 1689	38.7 – 39.7	1011
15:30 o'clock	100 – 111	31.1 – 32.2	1010

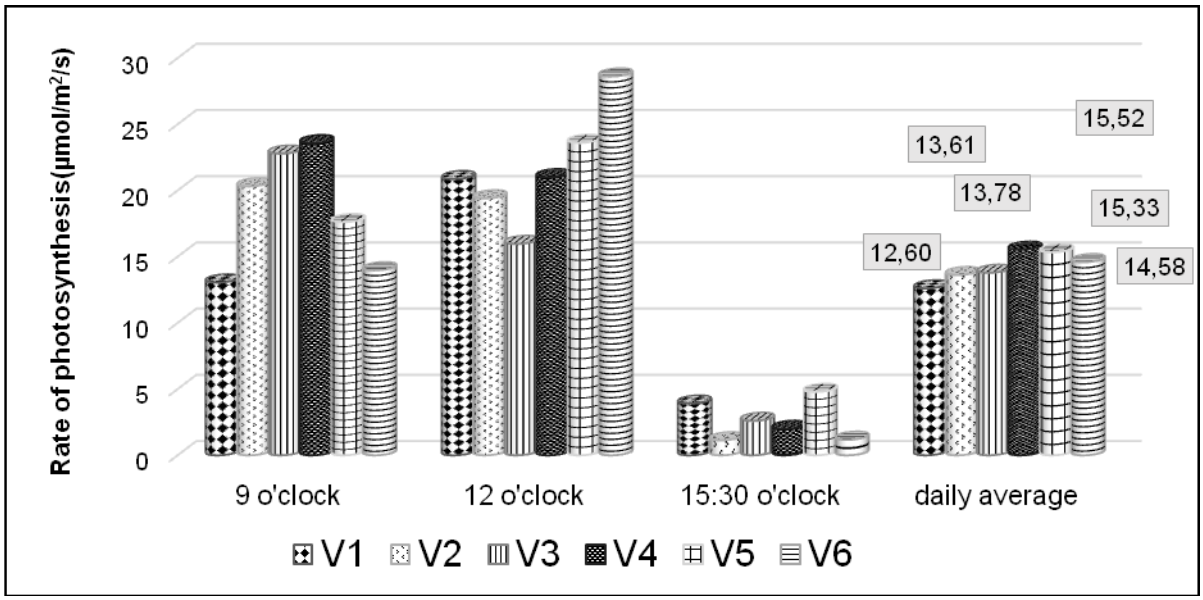

Figure 2. Diurnal variation of the photosynthesis process in sunflower under the influence of effluent irrigation obtained by wastewater treatment

Nitrogen is the main element in the composition of plant tissues of amino acids, alkaloids and chlorophyll. Without nitrogen, the sunflower plant cannot grow, because it enters the structure of proteins without which the plant tissues cannot form. In the absence of nitrogen, or poor supply of this element, the plants remain small, have a small leaf area and therefore a low assimilation capacity. The nitrogen content of the leaves was between 2.34%, in the version fertilized with N80P80K80 applied to the preparation of the germination bed and 3.50% in the variant fertilized with N80P80K80 + N70 2 applications with treated water in a dose of 50% (Table 3). Abbadi, J., et al. 2008, concluded that a leaf nitrogen content above 4% may indicate over-fertilization, and nitrogen is usually the most important chemical component in the soil-plant system irrigated with effluents. Phosphorus is involved in most vital processes, and a normal nutrition with phosphorus is achieved in most plants at concentrations between 0.2-0.6%. The phosphorus content of sunflower leaves showed the highest values (0.32-0.35%) in the variants in which N70 came from treated water. The results obtained indicate that the sunflower plants were optimally supplied with total phosphorus by applying treated water in 2-4 applications at a dose of 25%, 33% or 50%. These values are consistent with the results of a study by the greenhouse, conducted by Abbadi and Gerendás, 2015, which found that 0.3-0.4% P in the leaves was associated with maximum seed and oil yield. Potassium plays a key role in the mineral nutrition of plants, its insufficiency

affecting many metabolic cycles. In the sunflower leaves the potassium content was between 1.78% in the control version and 3.20% in the version fertilized with N80P80K80 + N70 an application with purified water in a dose of 100%.

Table 3

The influence of treated water on the N, P, K content of sunflower leaves

Variants	Nt (%)	Pt (%)	Kt (%)
V1-N80P80K80 applied to the preparation of the germination bed	2.34	0.24	1.78
V2-N80P80K80+N70 (nitrogen from ammonium nitrate)	2.62	0.26	2.58
V3- N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 4 doses of 25%)	2.96	0.35	2.89
V4- N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 3 doses of 33%)	2.70	0.35	2.58
V5- N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 2 doses of 50%)	3.50	0.33	2.70
V6- N80P80K80+N70 (nitrogen from treated water, applied in a single dose of 100%)	3.14	0.32	3.20
Optimal supply range	2.0-3.4	0.25-0.49	1.5-2.9

The results obtained from sunflower in the vegetation house, in different variants of application of treated water as fertilizer, show us that the N / P ratio is below 12.5, and that between nitrogen and potassium oscillates around 1 (Table 4). These values indicate that the nitrogen, phosphorus and potassium content of the treated water leads to a good supply in N, P, K of sunflower plants, but to obtain an N / P ratio with values higher than 12.5 the plants should have a higher nitrogen content in the leaves.

Table 4

Ratio values of tehe N / P and N / K in sunflower plants, depending on the application of treated water in the form of fertilizer

Variants	N/P	N/k
V1-N80P80K80 applied to the preparation of the germination bed	9.75	1.31
V2-N80P80K80+N70 (nitrogen from ammonium nitrate)	10.08	1.02
V3- N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 4 doses of 25%)	8.45	1.02
V4- N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 3 doses of 33%)	7.72	1.05
V5- N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 2 doses of 50%)	10.61	1.30
V6- N80P80K80+N70 (nitrogen from treated water, applied in a single dose of 100%)	9.81	0.98
Optimal supply range	≥12,5	2/1

The production results recorded for sunflower show an increase in productivity compared to the control variant, depending on the application of different fertigation doses with treated water (Table 5). It was noted with the best results on production (4427.5 kg / ha), the variant in which the dose of 70 kg N / ha, required in vegetation, was ensured by irrigation with fractional treated water in two doses of 50%, starting with the phase of 5-7 leaves, which achieved a 10% increase in production, compared to the control variant. In this context, it should be emphasized that wastewater, subject to the treatment process, can be a source of fertilization for energy plants. Research on sunflower cultivation, by Zaki Safi-Naz, Shaaban M.M, 2015. and Abbas Ali Yazdani et al. 2018 showed production increases for wastewater irrigation.

Table 5

Influence of fertigation with effluent obtained by wastewater treatment on sunflower production

No. Var.	Fertigation variant	Production (kg/ha)	Relative production (%)	The difference compared to the control (Kg/ha)
V1	N80P80K80 (applied to the preparation of the germination bed)	4026.0	100	Control
V2	N80P80K80+N70 (nitrogen from ammonium nitrate)	4281.8	106.4	255.8
V3	N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 4 doses of 25%)	4122.3	102.4	96.3
V4	N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 3 doses of 33%)	4298.3	106.8	272.3
V5	N80P80K80+N70 (nitrogen from purified water, applied in fractions, in 2 doses of 50%)	4427.5	110.0	401.5
V6	N80P80K80+N70 (nitrogen from treated water, applied in a single dose of 100%)	4358.8	108. 3	332.8
LSD 5%=755.21 kg/ha				

The production of seeds obtained from sunflower, in the different fertigation variants, was positively correlated with the seed yield per caltidium and with the weight of 1000 grains (Figure 3). The maximum values of the production components, namely the seed yield per calaridium (58.3%) and the mass of 1000 grains (69 g) were recorded by irrigation with an effluent of wastewater treatment, applied in 2 steps of 50%, starting with the 5-7 leaf phase of the plant.

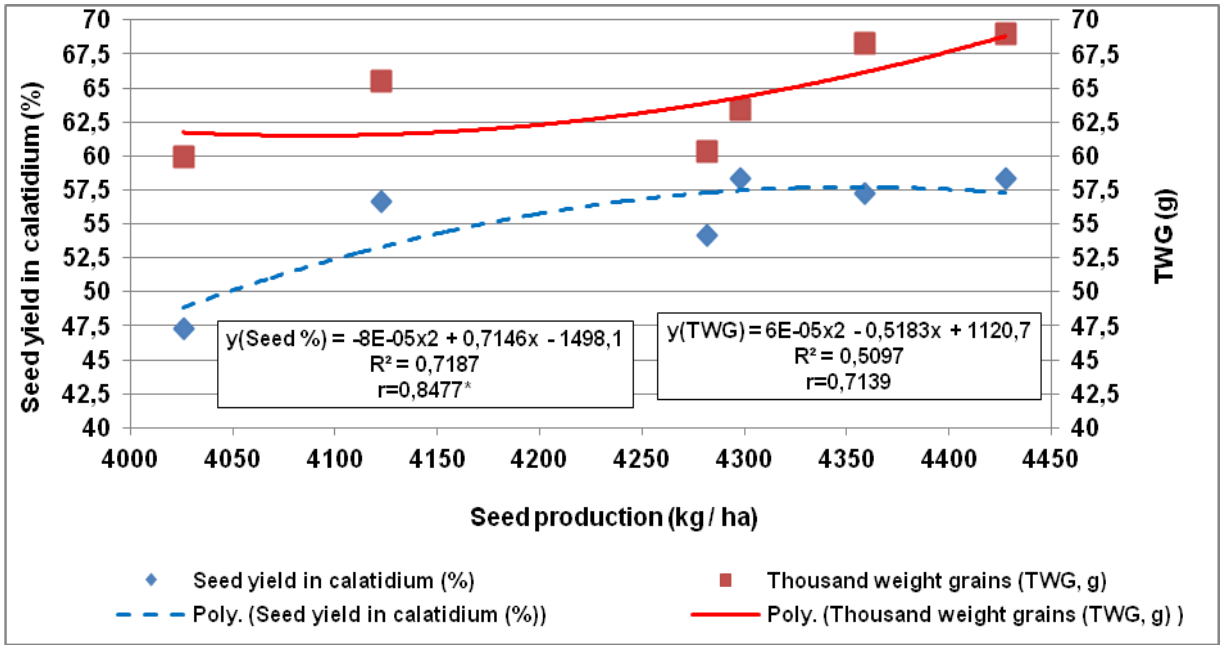

Figure 3. Correlations between sunflower production by weight of one thousand grains and seed yield / calatidium, under the influence of purified water fertility

CONCLUSIONS

The sunflower crop reacted well to the fertigation with the effluent obtained by wastewater treatment.

A distinctly significant positive correlation was made between the leaf surface index and the calatidium diameter.

Fertilization with purified water, applied in 2-3 stages led to the maximum accumulation of CO2 through the process of photosynthesis in sunflower (15.33-15.52 mm CO2 / m2 / s).

Irrigation with treated water resulted in a good supply of sunflower plants in NPK.

It was noted with the best production results (4427.5 kg / ha), the variant in which the dose of 70 kg N / ha, necessary in vegetation, was ensured by irrigation with fractional treated water in two doses of 50%, starting with the phase of 5-7 leaves, which achieved a 10% increase in production, compared to the control variant.

The production of seeds, obtained at sunflower in the different variants of fertigation, was positively correlated with the yield of seeds per calatidium and with the weight of a thousand grains.

The maximum values of the production components, respectively the seed yield per calatidium (58.3%) and the weight of one thousand grains (69 g) were registered by irrigation with an effluent obtained by wastewater treatment, applied in 2 stages of 50 %, starting with the 5-7 leaf phase of the plant.

ACKNOWLEDGEMENT

This work was supported by a grant of the Romanian Ministery of Research and Innovation CCDI - UEFISCDI, Project INNOVATIVE TECHNOLOGIES FOR IRRIGATION OF AGRICULTURAL CROPS IN ARID, SEMIARID AND SUBHUMID-DRY CLIMATE, project number PN-III-P1-1.2-PCCDI-2017-0254, Contract no. 27PCCDI / 2018, within PNCDI III.

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