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THE RESPONSE OF POTATO (*SOLANUM TUBEROSUM* L.) TO BIOLOGICAL DIGESTER, ORGANIC MATTER AND QUALITY OF TREATED WATER

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Abstract

A field experiment was carried out at the second research station Al Bandar, College of Agriculture, University of Al-Muthanna. There were two main factors in this experiment: the first factor included four types of watering, namely water of Euphrates river (N), Euphrates water magnetized by 2000 gauss (M), Sold free bio-digester water mixed with Euphrates water 1:1 ratio (F), and Euphrates water pressed into biogas tanks under 5 bar (A). The second factor was fertilizing potato plants with 50ton ha^{+1} by a. Aerobically decomposed buffalo manure mixed with water 10: 90 (A), and b. Deposited buffalo manure from previous tanks mixed with water 10: 90, (An) besides untreated control, treatments were replicated 3 times, to investigate the responses of potato growth, yield and soil properties. The results of the study showed that bio-digestion products (the quality of irrigation water A and organic fertilizer An) significantly affected most of the studied characteristics compared to other treatments. As for the interaction between the different types of irrigation water with organic fertilizer treatments did not affect most characteristics of the studied potato growth.
***Keywords*:** Potato (*Solanum tuberosum* L.), biological digester, organic matter, treated water.

Introduction

Potato (*Solanum tuberosum* L.) is one of the main crops, as tubers are a valuable source of many essential minerals (Alamar *et al.*, 2017). It can adapt to the various environmental conditions in tropical regions. It has also a high yielding potential per unit area, which is essential for ensuring food security, especially in developing countries. In addition, it is a source of iron and vitamins B1, B3 and B6 and minerals (Fantaw *et al.*, 2018). Moreover, it is a source of dietary antioxidants, which may play an important role in preventing aging-related diseases and is a source of dietary fiber (Mulatu *et al.*, 2005). Biogas production has spread and expanded in many countries of the world (Kemausour *et al.*, 2018). The reason for this is that the anaerobic biological digestion system has many advantages that can be used as organic raw materials from various sources, and a small household system or a large system of the manufacturer can be created (Wang *et al.*, 2016 and Dahiya *et al.,* 2018). Anaerobic digestion is a very sensitive process, carried out by microorganisms linked together in a complex society that exists in a closed technical system, controlled by the operator of the biogas plant. There are many factors affecting this process, including temperature and feeding of the biological digester with waste and changing concentrations of solids to Liquid and accumulation of process-inhibiting metabolites and many others (Theuerl *et al.*, 2019). Organic fertilizers improve physical, chemical, and biological soil properties in addition to improving the growth and productivity of agricultural crops. The use of organic fertilizers can reduce the use of chemical fertilizers (Gao *et al.*, 2020). With a growing interest in the use of renewable energy, bioenergy production and its by-products are important organic sources (Zheng *et al.*, 2016). The by-products of the anaerobic digestion of organic matter are among the best organic fertilizers to stimulate the soil, as it is a rich source of nutrients and organic substances (Gao *et al.*, 2020). Using this source as an organic fertilizer, it is possible to reduce the use of chemical fertilizers by up to 50%, which reduces production costs as well as increasing soil fertility for high yield yields (Islam *et al.*, 2010). The passage of water through a magnetic field is claimed to improve the physical, chemical and biological properties of water in many different applications (McMahon, 2009). There is still no clear understanding of the mechanisms underlying these changes and the effects that water treatment magnetically causes on seed germination, barbecue growth, physiological processes, and outcomes (Alderfasi *et al.,* 2016). The aim of this research is to study the effect of biogas products and the quality of treated irrigation water on some growth characteristics of potato.

Materials and Methods

A field experiment was carried out at Al Bandar research station, Agriculture College, Al-Muthanna University, during 2017 -2018 potato growing season. Samawa is located at 31.3188°N, 45.280° E, 9m elevation. A bio digester ($25.6m^3$), where, 10% diluted buffalo waste mixed with water was added, on 2nd October 2018, with daily feeding of 80 kg mixed with 800 liters of water, addition was continued up to 10th. October 2018, addition was accompanied with the collection of biogases. Experimental area was plowed by the flip-flop plow to a depth of 30 cm, Soil samples were taken chemical and physical analysis (Table 1).

Table 1 : Soil chemical and physical properties of the cultivated field pre planting

Property	Values
$pH_{1:1}$	7.4
$EC_{1:1}$	5.9 dSm^{-1}
Ca soluble	3.57 $meqL^{-1}$
Mg soluble	12.08 $meqL^{-1}$
Na soluble	36.43 $meqL^{-1}$
K soluble	1.06 $meqL^{-1}$
CO_3 soluble	-
HCO_3 soluble	3.57 $meqL^{-1}$
SO_4 soluble	15.00 $meqL^{-1}$
Cl soluble	40.33 $meqL^{-1}$
Texture	Sandy Loam
Sand	720 gKg^{-1} soil
Silt	135 gKg^{-1} soil
Clay	145 gKg^{-1} soil

Water diluted buffalo waste was placed on nylon in a pile on 9th, May 2018, and the weekly stirred for 3 months. Finally, aerobically decomposed manure (A) was dried and used as, soil fertilizer at rate of 50 $ton.ha^{-1}$. Whereas, organic waste (An) produced from the biological digester, which was fermented for 30 days, also applied as a fertilize at rate of 50$ton.ha^{-1}$ (Table, 2). Drip irrigation was applied for each individual type of water namely Euphrates water, as a control-check treatment (N), Magnetized Euphrates water by 2000 gauss (M), Solid free solution extracted from bio digester mixed with Euphrates water 1:1(F), and Euphrates water compressed into biogas under pressure of 5 bars to 400 liters tanks possesses a side inlet at the bottom and 2 inlets at the top one for monitoring the water level in the tank and the other for bio gas extractions after purifications (A). 300 L tanks inlets were closed before it was filled with water, then biogas was compressed through the bottom inlet of the tanks, at pressure of 5 bars to dissolve the water-soluble gases, especially CO_2.

Table 2 : The applied organic fertilizers.

Property	Units	Before decomposition	After decomposition	
			Aerobic	An aerobic
pH $_{1:10}$	-	7.8	7.7	7.6
EC $_{1:10}$	dSm^{-1}	15.8	15.9	5.8
Total nitrogen	%	1.55	1.44	1.42
Total phosphorus	%	0.47	1.58	0.71
Total potassium	%	1.20	0.92	1.19

Potato plants were fertilized by aerobically composed manure fertilizer (A), and anaerobically decomposed manure (An), besides unfertilized control (0), to represent factor B. Soil pH , electrical conductivity (EC) , dissolved ions, including positive one's calcium, magnesium, potassium, sodium, and negative ions, such as carbonates, bicarbonate, chlorides, and sulfates were measured (Richards (1954). Strip Plot Design was selected to this trail, where collected data were analyzed with GenStat Statistical Program, version 12.

Results and Discussion

The effect of different irrigation water quality on plant length, number of leaves per plant, and number of branches per plant

Table (3) shows the effect of different irrigation water quality on plant length, number of leaves per plant and number of branches per plant, as the results of the statistical analysis showed that there are significant differences resulting from the effect of different irrigation water quality on the characteristic of plant length, as the quality of irrigation water A has a significant effect on The length of the plant outperformed the quality of irrigation water F and recorded 35.77 29.11 cm in succession, while there were no significant differences between the quality of irrigation water A, M and N and the values were 35.77, 31.86 and 32.93 cm in succession, also there were no significant differences between the quality of irrigation water F And M and N whose values were 29.11, 31.86 and 32.48 cm, respectively. It is also noted from the data of Table (3) that the quality of the different irrigation water has a significant effect on the number of leaves in the plant, as the quality of the irrigation water A was significantly superior to the quality of M and was about 49.76 and 32.47 in succession, whereas it did not significantly outperform the water quality treatments N and F, which were about 40.76 and 47.87 respectively. In contrast, there were no significant differences in xxx between water quality N and M. As with the number of plant branches, the results showed that the quality of the different irrigation water did not significantly affect the number of plant branches in the net significantly.

Table 3 : The effect of irrigation water quality on plant length, number of leaves and number of branches

Treatments	plant length	Number of branches. $Plant^{-1}$	Number of leaves. $Plant^{-1}$
	Cm	-	-
N	32.93	40.07	5.13
M	31.86	32.47	3.51
A	35.77	49.76	5.22
F	29.11	47.87	5.62
L. S. D. 0.05	4.088	10.6	n. s.

The effect of different irrigation water quality on plant dry weight, dry weight of tubers and biological yield

Table (4) shows the effect of different irrigation water quality on the dry weight of the plant and the dry weight of the tubers and the biological yield, as the results of the statistical analysis showed that the quality of the different irrigation water did not statistically affect the dry weight of the plant. The results of the statistical analysis showed that the quality of the different irrigation water significantly affected the dry weight of the tubers, as it significantly affected the quality of irrigation water A on the dry weight of the tubers compared to the quality of irrigation water M, F and N and the values were 6.321, 3.997, 4.531 and 4.304 $ton.ha^{-1}$ respectively, while there were no statistically significant differences between the quality of irrigation water MF and N. The results also showed that the quality of the different irrigation water significantly affected the values of the biological yield, as the quality of irrigation water A significantly outperformed the quality of irrigation water M, N, and F with values of 7.778, 4.987, 5.265, and 5.755 $ton.ha^{-1}$ respectively, while there were no significant differences between the parameters of irrigation water quality M, N, and F. It is noted that the dry weight of the tubers increased the quality of irrigation water A, and this was also reflected on the characteristic of the biological yield.

Table 4 : Effect of irrigation water quality on plant dry weight, tubers dry weight and biological yield of plant

Treatments	Plant dry weight	Tubers dry weight	Biological yield of plant
	$ton.ha^{-1}$		
N	0.96	4.304	5.265
M	0.99	3.997	4.987
A	1.46	6.321	7.778
F	1.22	4.531	5.755
L. S. D. 0.05	n. s.	1.377	1.589

The effect of compost A and An on plant length, leaf number and number of branches

Table (5) shows that the organic fertilizer A and An did not significantly affect plant length, number of plant leaves and number of plant branches in comparison with the measurement treatment 0 in the characteristic of plant length, number of leaves per plant and number of branches per plant.

Table 5 : The effect of organic fertilizers A and An on the plant length, number of leaves and number of branches

Treatments	Plant length	Number of leaves	Number of branches
	cm	-	-
0	31.71	42.40	5.11
A	32.46	40.10	4.82
An	33.07	45.12	4.68
L. S. D. 0.05	n. s.	n. s.	n. s.

The effect of compost a and an on the dry weight of the plant, the dry weight of the tubers and the biological yield of the plant

Table (6) shows the effect of organic fertilizer A and An on the dry weight of the plant and the dry weight of the tubers and the biological yield of the plant. The results of the statistical analysis showed that the organic fertilizer A and An did not significantly affect compared to the measurement currency 0 in the characteristic of dry weight of the plant, while there were significant differences in the weight of the weight Dry matter of tubers, as the organic fertilizer An was significantly superior to the treatment of 0 and its value was 5.29 and 4.48 $ton.ha^{-1}$, respectively, while there were no significant differences between the organic fertilizer A and An, and also organic fertilizer A did not exceed the treatment measure 0. As for the characteristic of the biological yield, the results of the statistical analysis showed that the organic fertilizer An was significantly superior to the treatment of 0 and their value was 6.55 and 5.47 $ton.ha^{-1}$ respectively, while there were no significant differences between organic fertilizer A and the treatment parameter 0 and organic fertilizer A And An. The superiority of the organic fertilizer An over the treatment of 0 in the dry weight classes of tubers and the biological yield may be attributed to its role in increasing the readiness of nutrients in the soil.

Table 6 : The effect of organic fertilizers A and An on the dry weight of plants and the dry weight of tubers and the biological yield of the plant

Treatments	Dry weight of plants	Dry weight of tubers	Biological yield of the plant
	$Ton.ha^{-1}$		
0	0.99	4.48	5.47
A	1.23	4.59	5.82
An	1.26	5.29	6.55
L. S. D. 0.05	n. s.	0.55	0.593

The effect of overlap between the quality of irrigation water and compost A and An on plant length, number of leaves, and number of branches

Table (7) shows the effect of the interaction between the quality of irrigation water and organic fertilizer A and An on the length of the plant and the number of leaves and the number of branches. The results of the statistical analysis showed that there were no significant effects of the interaction between the quality of the different irrigation water and the different organic fertilizer treatments on the length of the plant and the number of leaves per plant and the number of branches with the plant.

Table 7 : The effect of interaction between irrigation water quality and compost A and An on plant length, number of leaves and number of branches

Treatments	Plant length	Number of leaves	Number of branches
	cm	-	-
N0	28.57	40.60	5.33
NA	33.24	30.87	5.00
Nan	35.62	48.73	5.07
M0	33.09	27.07	3.47
MA	29.72	34.00	3.53
Man	32.76	36.33	3.53
A0	33.70	49.93	5.60
AA	36.44	50.87	5.07
AAn	37.19	48.47	5.00
F0	31.49	51.99	6.06
FA	29.10	44.67	5.67
Fan	26.72	46.96	5.13
L. S. D. 0.05	n. s.	n. s.	n. s.

Effect of interaction between irrigation water quality and organic fertilizer A and An on the dry weight of the plant, the dry weight of the tubers and the biological yield of the plant

Table (8) shows the effect of interaction between the quality of irrigation water and organic fertilizer A and An on the dry weight of the plant, the dry weight of the tubers and the biological yield of the plant, and notes from the results of the statistical analysis that the interaction between the treatments led to a significant effect on the dry weight values of the plant, as the interaction factors A0 and FA exceeded AAn on the interaction coefficients MA, F0, M0 and N0 with values of 1.564, 1.558, 1.490, 1.006, 0.976, 0.817, and 0.588 $ton.ha^{-1}$ respectively. The n0 interaction treatment was significantly superior by registering the lowest value compared to the coefficients A0, FA, AAn, AA, NAn, and MAn. The values were 0.588, 1.564, 1.558, 1.490, 1.318, 1.270, and 1.149 $ton.ha^{-1}$ respectively. There were no significant differences between the coefficients of FAn, MAn, NAn, AA, AAn, FA, A0 and they reached 1.137, 1.149, 1.270, 1.318, 1.490, 1.558, and 1.564 $ton.ha^{-1}$ respectively, between the coefficients of MA, FAn, MAn, NAn, and AA which Values were 1.006, 1.137, 1.149, 1.270, and 1.318 $ton.ha^{-1}$ respectively, between NAn, MAN, FAn, MA, F0, and M0, and the values were 1.490, 1.149, 1.137, 1.006, 0.976, and 0.817 $ton.ha^{-1}$ respectively, between N0, M0, F0, MA, and FAn and their values were 0.588, 0.817, 0.976, 1.006, and 1.137 $ton.ha^{-1}$ respectively.

Table 8 : The effect of interaction between irrigation water quality and organic fertilizer A and An on the dry weight of the plant, the dry weight of the tubers and the biological yield of the plant

Treatments	Dry weight of plants	Dry weight of tubers	Biological yield of the plant
	$ton.ha^{-1}$		
N0	0.588	3.69	3.69
NA	1.025	3.16	3.16
NAn	1.270	6.07	6.07
M0	0.817	3.35	3.35
MA	1.006	4.15	4.15
MAn	1.149	4.48	4.48
A0	1.564	5.60	5.60
AA	1.318	6.65	6.65
AAn	1.490	6.71	6.71
F0	0.976	5.29	5.29
FA	1.558	4.39	4.39
FAn	1.137	3.91	3.91
L. S. D. 0.05	0.456	n. s.	n. s.

Conclusion

It is noted that the treatment of the quality of irrigation water A was significantly superior to other treatments in the characteristic of plant length, number of leaves, dry weight of tubers and biological yield, as well as significantly greater than the treatment of fertilizer An in the dry weight of tubers and the biological yield, and it is noted that these two treatments are by-products of the bio-digester system. Environmentally, agriculturally and economically important, the establishment of bio-digestion systems, as it has an advantage in improving the management of organic waste and its positive impact on plant growth, in addition to benefiting from gases released from aerobic decomposition into the atmosphere and aggregating them into the bio-digestion system. Renewable and sustainable energy.

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