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ORIGINAL ARTICLE

EFFECT OF DRY AND LIQUID WHEY ADDITION TO REDUCE GROWTH MEDIA SALINITY AND STIMULATE GERMINATION OF TOMATO SEEDLING UNDER GREENHOUSES CONDITIONS

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Abstract: A pots experiment was conducted in greenhouses at the College of Agriculture, University of Basrah, during the autumn season of 2017 to study the effect of different levels of treatment of liquid and dry Whey to soil mixed with animal manures as a growth media, Whey adding at levels 25, 50 and 75 % as a liquid and 1, 2 and 4% as a dry matter. Results showed a decrease in the failure rate of seedlings germination with whey addition and a reduction in E.C . the application of dry Whey at 1 to 2 and 4% with the animal manure effect significantly on decline E.C .while the liquid Whey in 25 to 50 and 75% led to a significant decrease in pH from 7.70 to 7.62 and 7.61, respectively. The concentration of dry Whey led to a substantial reduction in pH values.

***Key words*:** Bulk density, Whey dry matter, Greenhouse, Tomato.

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1. Introduction

Tomato crop, *Solanum esculentium* L. is one of the important and necessary vegetable crops in the world, especially in Iraq, due to its high nutritional importance, as its fruits contain vitamin B, C, carbohydrates, lycopene and carotene, as well as many minerals [Desher and Abdel Kariem (2018), AL-Taey *et al*. (2022)]. Tomato contains vitamins A, B1, B2, B3, and C. Also, it has 13 mgm^{-1} calcium, 13 mg calcium, 27 mg phosphorus, 244 mgm^{-1} potassium and 0.5 mgm^{-1} iron. Besides, tomato contains of 22 calories, 1.1 gm protein and 4.7 gm carbohydrate [Watt and Mernil (1963)].

Many nutrients available in the soil or added are exposed to many processes of loss by washing, volatilization, stabilization and sedimentation, and the climate of Iraq, especially in the middle and south, is hot and dry in summer, and the degree of soil interaction (pH) tends towards the basic, which leads to a decrease in the readiness of many nutrients by restricting its movement [Al-Juthery *et al*. (2020)] and then the plant not obtaining its need of these elements, which leads to weak germination and growth, a decrease in plant production and a deterioration in its quality, so it became necessary to compensate for this by adding some additives or complementary sources nutrients contain components that the plant can benefit from in germination and growth stages by adding them to the soil or spraying on the vegetative system or adding them with irrigation water [Mahmood *et al*. (2020), Al-Taey and Al-Musawi (2022)].

The soils of southern Iraq are considered limestone soils with a high base and low fertility due to the lack of organic matter content in them, such as heavy soils with clay and alluvial textures east of Basra and using raw water of high salinity and high alkalinity [Mohamed

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(2013)].

The global trend is towords the use of organic materials or plant origin as a source of fertilizer for the purpose of reducing the pollution of the environment and agricultural soils with chemical [AL-Taey (2017), Toman *et al*. (2020)] and the production of agricultural crops safe for humans and animals and compensation of organic matter, which loses soil as a result of intensive agriculture. Organic fertilizers additionally enhance soil physical and compound properties and reduce the requirements for mineral composts, which is reflected in an increase in vegetative growth and yield of plants [AL-Bayati *et al*. (2019) and Ali *et al*. (2021)].

The use of Whey is one of the recent trends in some fields to raise the nutritional value of the product, which is of importance in feeding the plant individually or overlapping with the combination of micro-nutrient elements in some characteristics of vegetative and flower growth and the components of the yield and its quality for most agricultural plants, where the Whey is one of the by-products of the dairy industry, including (cheese). It was found that increasing the concentration of Whey helps to increase the concentration of plant pigments, including (chlorophyll), as it increases the speed of transpiration, which increases the speed of absorption and transfer of nutrients [AL-Obidy (2006), Drazkiewicz (1994)].

This study aimed to select the appropriate kind of liquid or dry Whey to decreased seedling death rate, salinity and improved pH of tomato growth media under greenhouse conditions in South region of Iraq.

2. Materials and Methods

A pot experiment was conducted under greenhouse conditions at the agricultural research station of the College of Agriculture, University of Basrah in the autumn season 2017 to study the effect of treating different concentrations of liquid and dry Whey to the soil and mixed with animal manure or animal manure only as agricultural growth media on tomato seedling death rate and some characteristics chemical and physical growth medium. The organic manure residues (cattle waste) were collected from cattle breeding farm in the animal field of the College of Agriculture. The sample was air dried and some plant residues were removed from it and passed through a 2 mm sieve and added to the treatments in the pots at a rate of 16 ton ha^{-1}. A sample of these wastes was sorted for the purpose of conducting some laboratory analyzes on them (Table 1).

Soil sample was collected from the surface layer of Sanam mount (West of Basra, Safwan region), air dried and sieved with a 2 mm sieve and a part of it was taken to measure some of the initial properties as shown in Table 2 [Page *et al*. (1982)].

Quantities of Whey samples were collected from local dairy products from Basra markets and dilution operations were performed on them according to the liquid addition treatments, and the lyophilization process was conducted to manufacture dry Whey powder for the above liquid treatments to be added to the dry treatments. A sample was taken from it and analyzed in the laboratory to determine some of its primary properties (Table 3).

The experiment was conducted with the following factors:

First: Agricultural media factor (M) included M1 animal manure only, and M2 1 volume of animal manure + 1 volume of soil.

Second: Type of Whey added, as two types of Whey were used in the experiment, which are T1 liquid Whey and T_2 dry Whey (Table 3).

Third: Whey levels (C), where liquid and dry Whey solutions and quantities were added as a media initial dose mixed with the culture media in order to help in the formation of primary leaves in seedlings. The liquid Whey concentrations were 25, 50 and 75%, while the dry Whey quantities were 1, 2 and 4%.

Thus, the experiment parameters were divided as follows.

M1T1: Control Treatment 1 (animal manure only).

M2T2: Control Treatment 2 (1 volume of animal manure + 1 volume of soil).

M1T1C1: (T_3) Animal manure + 25% liquid Whey.

M1T1C2: (T_4) Animal manure + 50% liquid Whey.

M1T1C3: (T_5) Animal manure + 73% liquid Whey.

M1T1C4: (T_6) Animal manure + 100% liquid Whey.

M1T2C1: (T_7) Animal manure + 1% dry Whey.

M1T2C2: (T_8) Animal manure + 2% dry Whey.

M1T2C3: (T_9) Animal manure + 4% dry Whey.

M2T1C1: (T_{10}) Animal manure + soil + 25% liquid Whey.

Table 1: Some chemicals and physical properties of animal manure (Cattle residual) used in study.

pH	EC dSm^{-1}	N %	P %	K %	O.M. %	O.C. %	C:N %	C:P %
7.60	8.11	1.48	0.1	0.53	36.82	23.17	17.9	239.5

Table 2: Some chemicals and physical properties of soil used in study.

pH	E.C	CEC	OM	$CaCO_3$	N	P	K	Texture
1:1	dSm^{-1}	Cmol kg^{-1}	g kg^{-1}	g kg^{-1}	% ppm			Loamy sand
7.8	4.6	7.85	1.02	104.2	0.02	0.13	0.91	

Table 3: Some chemicals and physical properties of acidity liquid and dry Whey used in study.

Properties	Whey		Unit
	Liquid	Dry	
Humidity	93.46	3.99	%
Protein	1.16	63.00	%
Fat	0.40	3.65	%
Minerals	0.7	0.5	%
N	7.10	7.10	$mg.100g^{-1}$
K	0.01	0.01	%
Ca	0.03	0.03	%
Fe	0.02	0.02	%
Ash	0.55	3.60	%
EC	1.12	1.12	dsm^{-1}
pH	5.37	5.37	—
TSS	5.57	5.57	$mg.100g^{-1}$
Roughness	-	15	%

M2T1C2: (T_{11}) Animal manure + soil + 50% liquid Whey.

M2T1C3: (T_{12}) Animal manure + soil + 75% liquid Whey.

M2T1C4: (T_{13}) Animal manure + Soil + 100 Liquid Whey.

M2T2C1: (T_{14}) Animal manure + soil + 1% dry Whey.

M2T2C2: (T_{15}) Animal manure + soil + 2% dry Whey.

M2T2C3: (T_{16}) Animal manure + soil + 4% dry Whey.

The planting media was added according to the treatments in pots with a capacity of 2 kg, then water was added within the limits of the field capacity and the growth media was treated with different concentrations of liquid Whey directly and by watering on the surface of the growing media in the pots and apply one week to it with irrigation water. Dry Whey was applied as a powder by mixing it with the soil before planting, and the remains of the above concentrations were added in the form of a ring around the stem of the plant on the surface of the growth media in the subsequent weekly additions. Seeds of hybrid tomato plants (Feton variety), with three seeds for the pot on 9-10-2017. The pots were placed under the conditions of the greenhouse. Each treatment is replicated 5 times and the treatments are distributed randomly.

When germination was completed at 8-10 days from planting, the percentage of deaths rate was calculated after 5 days of completing nurseries germination, then the process of thinning the plants and keeping one plant per pot was carried out in all experiments, and watering the growing plants in the pots continued with fresh water from filtering some of the laboratories with the addition of these concentrations of liquid and dry solutions of Whey by one addition per week throughout the experiment period. % of germination, E.C and pH were taken at three period appointments after 2, 4 and 6 weeks of germination (dated 15 Oct., 1 Nov. and 15 Nov. 2017).

The data were analyzed as a factorial experiment with two factors, then the means were compared according to the RLSD test at the 0.05 level of significance.

2.1 Seedling death rate (%)

The process of calculating the dead plants relative to all the grown plants was carried out five days after the completion of seed germination in the experimental treatments.

2.2 Media (E.C) dSm^{-1} and pH

Media (E.C) dSm^{-1} and pH were measured in soil extract (1:1) using a conductivity and pH meters and as described in Page *et al*. (1982), during three times of the experiment and after 3 days of adding Whey treatments.

3. Results and Discussion

3.1 Seedling death rate (%)

The data in Table 4 refer to the percentage of seedling death rate of tomato plants after five days of completion of germination in the experimental units. As a general average, it is clear that the increase in the level of the apply liquid Whey from 0 to 75% led to a gradual and significant decrease in the death rate from 2.33 to 0% and this decrease was statistically significant by twice at the media and high levels of both types of Whey compared to the two control treatments.

The results indicate in the two control treatments (without adding any level of liquid or dry Whey) that the percentage of seedling death was negatively affected by the absence of any nutrients in the growth media that could help with the presence of nutrients ready for seed germination and thus the percentage of losses (lack of germination) was significantly significant in this treatment [Gómez *et al*. (2010)]. On the other hand, add liquid Whey solutions and the dry quantities of it significantly reduced the death rate for tomato seedling, as they contributed to increasing the plants tolerance to salinity in the growth media (Tables 1 and 2) and successfully helped germination as a result of providing a media with an appropriate acidity level with a good readiness of the starting solutions of some nutrients such as nitrogen. When comparing the two growth media as a general average, results of Table 3 showed that there is an increase in the percentage of seedling death in the two control treatments, which amounted to 2.33 and 1.66 %, respectively followed by the treatment of growth media (animal manure only) with a value of 1.13% and an increase of 6.19 for the treatment of growth media (the volume of animal manure to the volume of soil), which recorded a death rate of 1.66%, and the reason may be due to the effect of salts in the waste of animal manure (Table 1), which negatively affected the germination and growth of seedlings.

3.2 Electrical conductivity E.C. (dSm^{-1})

The results in Fig. 1 show that the addition of liquid or dry Whey and the type of growth media had a significant effect on the electrical conductivity of the growth media compared to the two control treatments at the end of the experiment. Where the results indicate that the addition of liquid or dry Whey has significantly reduced the electrical conductivity of the media compared to the two control treatments. As it was found that the increase by apply liquid Whey concentrations from 25 to 50 and 75% in the growth media of animal manure only led to a significant decrease in the electrical conductivity from 7.11 to 6.94 and 6.57 dSm^{-1} with a decrease of 2.39 and 7.59%, respectively.

As for the treatments of adding dry Whey, the increase in the concentration of 1 to 2 and 4% of the growth media from animal manure only led to a significant decrease in the electrical conductivity from 7.78 to 7.27 and 7.11 dsm^{-1}, with a decrease of 6.55 and 8.61%, respectively. The same applies to the growth media of animal manure: soil (1:1), the increase in the addition of liquid or dry Whey concentrations led to a significant decrease in the electrical conductivity compared to the two control treatments. The reason for this may be due to the fact that the type of Whey used has a low electrical conductivity of about 1.12 dSm^{-1} (Table 3) and when it was added periodically to the plants on the surface of the soil in pots, it washed away the salts originally present in the growth media as well as to improve it to the physical and chemical properties of soil (Table 2), which was positively reflected on salinity. These results are consistent with what was found by El-Delfi (2013) that the salinity of the soil used in agriculture decreased to 6.44 dm^{-1} when irrigated with saline water 8.0 dSm^{-1} and the addition of different levels of composted organic fertilizers (animal manure) [Tmanios (2004)].

3.3 pH

Results in Fig. 2 show a significant effect of the treatments of adding liquid or dry Whey and growth media on media pH, where the addition of treatments achieved a significant decrease in the pH value compared to the two control treatments. It is also clear that the increased addition of liquid Whey concentrations from 25 to 50 and 75% led to a significant decrease in pH from 7.70 to 7.62 and 7.61 as a general average during the sampling stages, with a decrease of 1.03 and 1.16%, respectively. As for the treatments of adding dry Whey, the increase in concentration from 1 to 2 and 4% led to a significant decrease in the acidity values of the media from 7.74 to 7.72 and 7.60 as a general average during the sampling stages with decreases of 0.25 and 1.81%, respectively.

The reason of this results may be due to the fact that the type of Whey used is acidic in origin and its

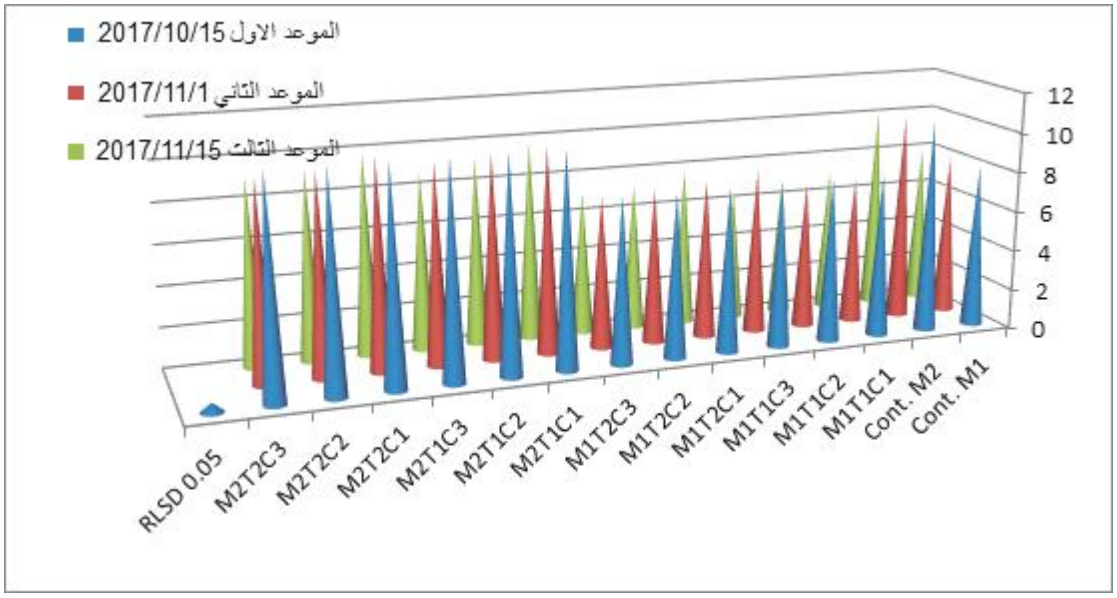

Fig. 1: Effect of adding Whey and growth media on media electrical conductivity (dSm^{-1}) of the growth media during the experiment periods

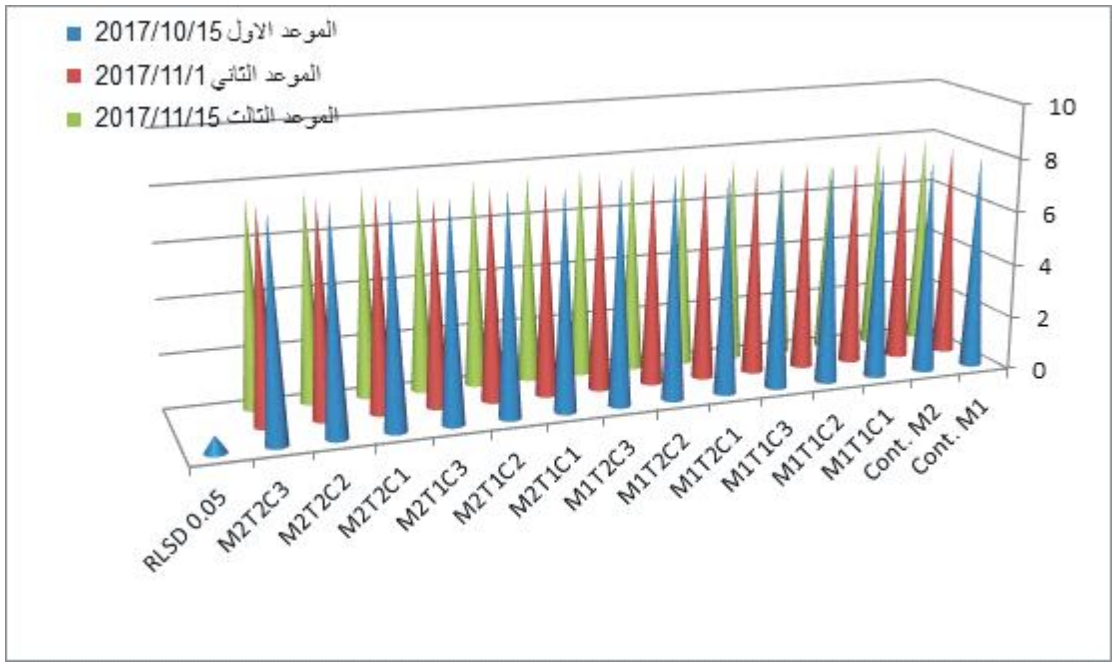

Fig. 2: Effect of adding Whey and growth media on media pH of during the experiment periods

acidity is low at around 5.37 (Table 3) and when it is periodically added to the plants to the surface of the soil in pots and daily watering with salt-free irrigation water led to a decrease in the acidity of the media during periods measurement as well as for washing these acid solutions of salts from the growth medium [Hussain *et al*. (2021) (Fig. 1).

Al-Maliki (2010) found that the composting of animal manure had a significant effect on the pH of the soil treated with animal fertilizers, where the composted manure gave the lowest rate of pH degree reached 7.73 at depth 0-30 cm and 7.62 at depth 30-60 cm which affect the lowering of the soil pH value through the acids formed and released from the decomposition of animal manure, in addition to that the low percentage of nitrogen in the fermented manure compared to the non-fermented manure may reduce the amount of ammonia released from the decomposition of the fertilizer, which usually raises the pH value of the soil.

Table 4: Effect of the level and type of Whey and the growth media on seedling death rate (%) after five days of germination.

Treatment/Concentration		C1	C2	C3	Mean
Control T1	2.33	-	-	-	0.76c
Control T2	1.66	-	-	-	0.55b
M1T1	-	1.66	0	0	0.55b
M1T2	-	1.66	0	0	0.55b
M2T1	-	1.33	0	0	0.44a
M2T2	-	1.33	0	0	0.44a
Mean	0.99b	0.99b	0a	0a	

As for the growth media treatments, it is clear from the results of Fig. 2 a significant decrease in the pH of the growth media treatments from animal manure only from 8.01 as a general average at the beginning of the experiment to 7.19 at the end of the experiment with a decrease of 0.10%, the soil pH was decreased with growth media that contained the animal manure. Soil decreased from 8.08 as a general average at the beginning of the experiment to 7.15 as a general average at the end of the experiment, with a decrease of 0.11% compared to the two control treatments that did not decrease the pH and remained at a rate of 7.90 at the beginning and end of the experiment [Tmanios (2004)].

4. Conclusion

The dry and liquid Whey led to an increase in the germination ratio of tomato seeds, and there is a significant effect of liquid and dry Whey addition reduces the salinity of the growth medium by reducing the Ec. The liquid and dry Whey addition reduced the pH of the soil.

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