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Effect of Dry and Liquid Wey Addition on Tomato (*Solanum esculentium* L.) Growth Properties Under Greenhouses Conditions-b

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Abstract. A pots experiment under greenhouses conditions were conducted at an agricultural research station related to Agriculture College / Basrah Univ. during the grown season 2017 - 2018 to statement the effect of different levels of treatment of liquid and dry Wey adding to soil mixed animal manures as a growth media on some tomato seedling properties, Wey adding at level 25, 50 and 75 % as a liquid and 1, 2 and 4 % as a dry.Results showed a significant improvement in all growth properties: The highest height of 33.11 cm was recorded in (1 animal manure :1 soil) treatment at a 2 % dry Wey. The highest number of branches was at dry and liquid Wey treatments, attaining 2 and 3.2 plant branch-1, and the highest average number of branches was recorded at the value of 3.55 plant branch^{-1} at (1 animal manure :1 soil) treatment. A significant number of leaves was 13 leaf plant^{-1} at the level of adding 50% of liquid spray and 12 leaf plant^{-1} at the level of addition of 2% of dry Wey; the highest average number of leaves has recorded a value of 13 leaf plat^{-1} of (1anmial manure:1soil) treatment. A significant value of shoot weight was at 75 % addition Wey liquid attained 6.99 gm plant^{-1} for shoot part compared with control and 25 % addition liquid Wey treatments.(1 animal manure:1 soil) treatment. Treatment of liquid Wey was applied at a concentration of 75%, giving a significant average of roots fresh weight is 0.123 gm plant^{-1}, adding animal manure treated with liquid Wey achieved the highest average weight of roots attains 0.156 gmplant^{-1}. Treatments of applied liquid Wey at a concentration of 75% were a superior average of dry shoot weight at 0.59 gm plant^{-1}.

Keywords. Greenhouse, Dry, Liquid, Morphological properties, Tomato, Wey .

1. Introduction

Tomato is one of the plants of the Solanaceae family that stresses the soil and responds well to fertilization, including the limited-growing varieties, as well as the varieties grown under protected conditions, which consume large quantities of fertilizer because they are unlimited growth varieties due to the length of their growing season [1,2].
Nitrogen has an important role in plant life, as it is one of the components of the chlorophyll molecule, protein and nucleic acids, and it is one of the main elements necessary for plant growth, as it helps in the growth and development of the plant, especially the vegetative part of plants because it enters the

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building of the protoplasm of plant cells [3,4]. Crops need nitrogen in the early stages of the plant's life and in quantities that vary according to the type of planted crop to ensure the development of the primary leaves that contribute to preparing the root with food and improving plant growth, as it leads to an increase in the growth of tomato seedlings such as plant height, number of leaves, number of branches, and fresh and dry weight [5,6].

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[2] , which leads to a decrease in the readiness of many nutrients by restricting its movement, 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 [7,8].

To find the best solutions to the problems of low fertility in soils and increase the growth of plants, the current study aimed to recycle and reuse industrial food waste because it is one of the features of progress in many countries of the world to preserve the environment on the one hand and its nutritional importance [9]. The use of Wey 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 the components of the yield and its quality for most agricultural plants, where the Wey is one of the by-products of the dairy industry [8]. As large quantities of it are produced annually and many products are made from it, and it is inferred from this that cheese whey contains a quantity of Wey protein in addition to its low pH, it was found that increasing the concentration of Wey 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 [10,11].

2. Materials and Methods

A pot experiment was conducted under greenhouse conditions at the agricultural research station of the College of Agriculture - University of Basrahduring the growing season 2017-2018 to study the effect of treating different concentrations of liquid and dry Wey to the soil or mixed with animal manure and animal manure only as agricultural growth media on some elements of tomato seedling growth. The animal manure (cattle residuals) 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).

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

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

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 [12].

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

Texture	K	P	N	CaCO3	OM	CEC	E.C	pH
Loamy sand	ppm	ppm%		g kg^{-1}	g kg^{-1}	Cmol kg^{-1}	dSm^{-1}	1:1
	0.91	0.13	0.02	104.2	1.02	7.85	4.6	7.8

Quantities of Wey samples were collected from local dairy products from Basrah markets and dilution operations were performed on them according to the liquid addition treatments, and the (lyophilization) process was conducted to manufacture dry Wey 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 know some of its primary properties (Table 3).

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

Properties	Wey		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	%
E.C	1.12	1.12	dsm^{-1}
pH	5.37	5.37	--
TSS	5.57	5.57	$mg . 100g^{-1}$
Roughness	-	15	%

The experiment was conducted with the following factors:
First: The agricultural media factor (M) included M1 animal manure only, and M2 : 1 volume of animal manure + 1 volume of soil.
Second: The factor of the type of Wey added, as two types of Wey were used in the experiment, which are T1 liquid Wey and T2 dry Wey (Table 3).
Third: Additive Wey levels factor (C), where liquid and dry Wey 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 Wey concentrations were (25, 50 and 75%), while the dry Wey 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: (T3) Animal manure + 25% liquid Wey
M1T1C2: (T4) Animal manure + 50% liquid Wey
M1T1C3: (T5) Animal manure + 75% liquid Wey
M1T1C4: (T6) Animal manure + 100% liquid Wey.
M1T2C1: (T7) Animal manure + 1% dry Wey
M1T2C2: (T8) Animal manure + 2% dry Wey
M1T2C3: (T9) Animal manure + 4% dry Wey
M2T1C1: (T10) Animal manure + soil + 25% liquid Wey
M2T1C2: (T11) Animal manure + soil + 50% liquid Wey
M2T1C3: (T12) Animal manure + soil + 75% liquid Wey
M2T1C4: (T13) Animal manure + Soil + 100 Liquid Wey
M2T2C1: (T14) Animal manure + soil + 1% dry Wey
M2T2C2: (T15) Animal manure + soil + 2% dry Wey
M2T2C3: (T16) Animal manure + soil + 4% dry Wey
The planting media was added according to the treatments first in plastic 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 Wey directly by watering on the surface of the growing media in the pots and apply one week to it with irrigation water. For the treatment of dry Wey, it was apply as a powder by mixing it with the soil before planting, and the remained 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. After that, the seeds of the hybrid tomato plants (Feton variety), which are commonly used recently in the desert areas in southern Iraq, with three seeds for the pot on 9-10-2017. The pots were placed under the conditions of the greenhouse of the agricultural research station - College of Agriculture - University of Basra. Five replications were replicated for each treatment and distributed randomly inside the plastic house.

When germination was completed after 8-10 days from planting, 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 Wey by one addition per week throughout the experiment period. Some growth measurements were taken on the growing plants, namely: plant height, stem diameter , branches number and number of leaves per plant for three periods, one measurement every two weeks on the following dates:

The first appointment is after 2 weeks of germination (dated 10/15/2017). The second date 4 weeks after germination (dated 1/11/2017). The third date after 6 weeks of germination (on 15/11/2017).

The plants were also stuffed from the area where the stem met the surface of the growth media and the roots were taken out from the growth media and cleaned with a clean cloth and the shoot fresh weight was calculated for them, then placed in the electric oven at a temperature of 65 °C for 48 hours and the dry weight of the shoot and root parts was taken. 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. Vegetative Growth Characteristics

Plant height (cm), Steam diameter (mm), Branch numbers ,Leaves number (leaf $plant^{-1}$) and Fresh and dry weight (gm) of shoot and root

3. Results and Discussion

3.1. Plant Height (cm)

Figure (1) shows a significant superiority ($P<0.05$) in the height of tomato seedlings when adding both liquid and dry Wey when compared to the two control treatments, where the average plant height in the two control treatments when using animal and animal manure: soil 4.3 and 4.6 cm. The growth media from animal manure and soil in a ratio of 1:1 and at a level of 50% addition of liquid Wey attain 6.3 cm at the beginning of cultivation and reached a maximum height of 7.8 and 18.6 cm for the two control treatments respectively and 31.3 cm for the treatment of growth media animal manure :soil with a level of apply 50% liquid Wey and 33.11 cm to treat the growth media. Animal manure : soil at a level of adding 2% dry Wey at the end of the experiment, respectively. The reason for the plant's height when using the Wey is attributed to its role in improving the tissues of the media forcultivation by increasing provide useful nutrients in the Wey, especially the nitrogen element that enters into building protein, which led to the possibility of absorbing these elements by the plant and their positive effect in the stages of plant growth [3]. The results of this study are in agreement with those of [13], which confirmed the height of maize plant when grown in media containing some fermented plant residues.

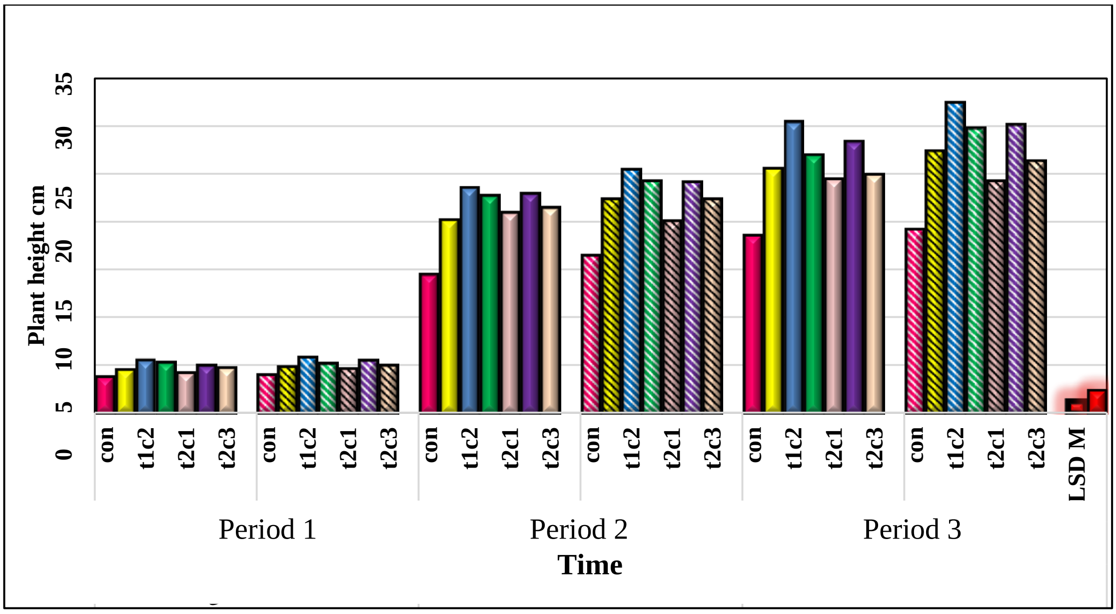

Figure 1. Effect of levels and type of Wey and the growth media on plant height (cm) during growth period.

The type of growth media had a significant effect on plant height, as it is clear from the figure that the treatment of growth media (1 animal manure: 1 soil) and that treated with dry Wey has outperformed of the treatments with a significant difference from the treatment of growth media for animal manure only and of the treatments in addition to the control treatment for all measurement periods, the highest average plant height was recorded in the third stage of measurement with a value of 33.1 cm, while the treatment (1 animal manure : 1 soil) and dry We treated recorded the lowest value with plant height of 24.6 cm, which in turn significantly compared of the control, which achieved 19 cm.

3.2. Steam Diameter (mm)

Figure (2) showed a significant effect ($P<0.05$) of adding liquid and dry Wey to the growth media on the stem diameter of tomato seedlings, as the average in the control treatments for growth media was 1.5 and 1.6 mm for the second stage of measurement, respectively. While the average diameter of the stem increased to 4 mm when apply liquid Wey at a concentration of 75% and dry Wey to 3.6 mm when added at a concentration of 4% at the second stage of measurement, while the maximum average diameter of the stem was about 4.65 mm when apply liquid Wey at a concentration of 50% compared to the two control treatments 2 and 2.35 mm at the end of the measurement period, respectively. This may be attributed to the role of nutrients included in the synthesis of Wey and nutrients, including nitrogen, one of the components of protein, potassium and calcium, which have a major role in building carbohydrates and transferring them to other parts of the plant, causing an increase in the size of the stem of the plant [14].

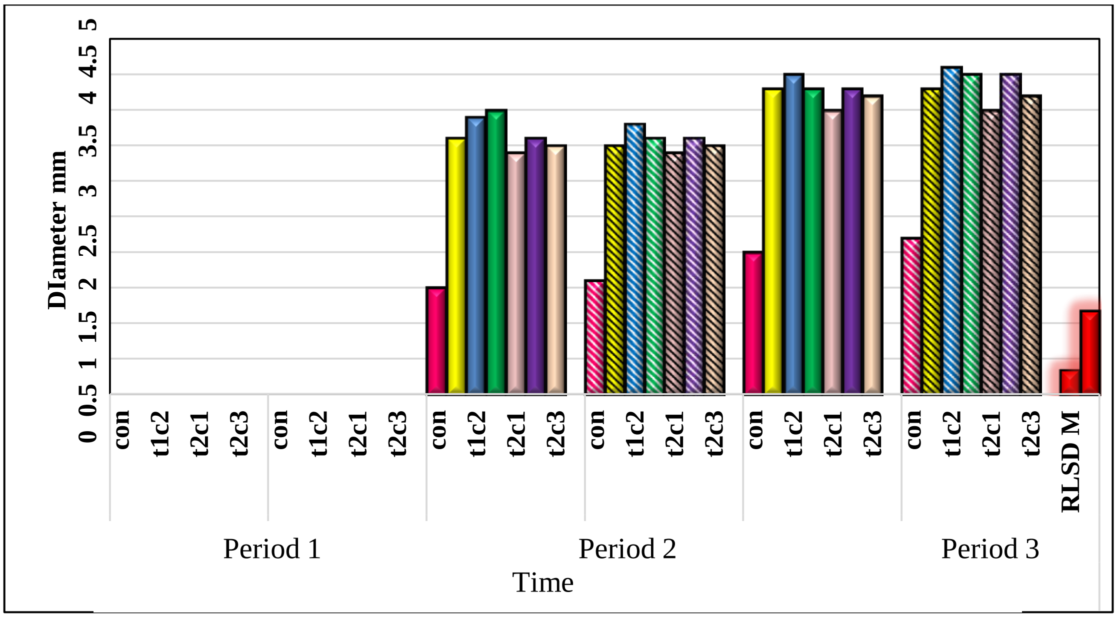

Figure 2. Effect of levels and type of Wey on the growth media on steam diameter (mm).

As for the effect of the type of growth media on the stem diameter of tomato plants, it is clear from the figure that the treatment of the growth media (1 animal manure : 1 soil) and the liquid Wey treatment has outperformed of the treatments with a significant difference from thetreatment of growth media for animal manure only and of the treatments in addition to the treatment of control and for all measurement periods, recorded the highest average diameter of the plant steam in the third stage of measurement with a value of 4.65 mm, while the treatment (1 animal manure : 1 soil) and the dry Wey treatment recorded the lowest value of steam diameter about 4 mm, which in turn significantly compared with control treatment, which it achieved 2.35 mm.

3.3. Branches Number (branch plant^{-1})

The results of Figure (3) show that the addition of liquid and dry Wey led to a significant superiority in the number of branches of tomato seedlings compared to the two control treatments of the two types of growth media. A highest number of branches was at apply dry and liquid Wey treatments attain 2 and 3.2 branch plant^{-1} at the end of the third period of measurements, while the average number of branches in the control treatments was 1.5 and 1 branch plant^{-1} for the two types of growth media, respectively. The reason may be attributed to the fact that the Wey contains many nutrients that improve the properties of the soil, as well as their rapid absorption by the soil, and thus led to the plant's response [13].

The type of growth media had a significant effect on the number of branches of tomato plants, as it is clear from the figure that the treatment of growth medium (1 animal manure: 1 soil) and the liquid Wey treatment has outperformed of the treatments with a significant difference from the treatment of growth media for animal manure only and of the treatments in addition to the control treatments and for all measurement periods, the highest average number of branches was recorded in the third stage of the measurement with a value of 3.55 branch plant^{-1}, while the treatment (1 animal manure: 1 soil) and the dry Wey treated gave the lowest value of the number of branches amounted to 2.5 branches plant^{-1}, which in turn significantly outperformed the control treatments, which achieved 1.7 branch plant^{-1}.

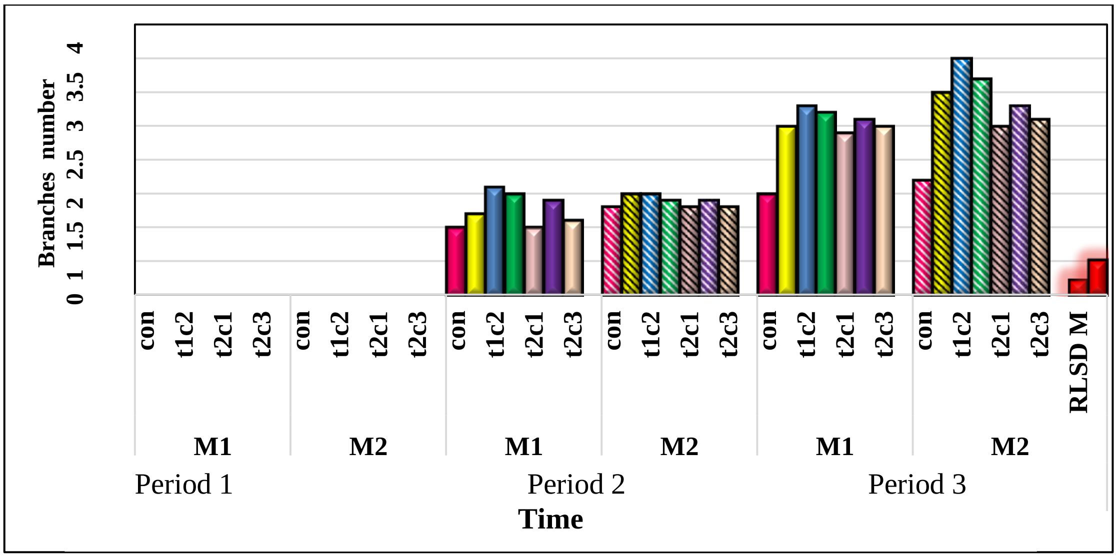

Figure 3. Effect of levels and type of Wey on the growth media on branches number (mm).

3.4. Leaves Number (leaf plant^{-1})

Results in Figure (4) indicate that the treatments to which dry and liquid Wey was added were significantly superior in the number of leaves of tomato seedlings compared to the two control treatments, where the average number of leaves was 13 leaf plant^{-1} at the level of adding 50% of liquid spray and 12 leaf plant^{-1} at the level of addition of 2% of dry Wey is superior to the samples of the two control treatments, in which the average number of leaves was 7 and 8, respectively, and the reason for this may be due to the abundance of nutrients released from the Wey and the improvement of the growth medium, which led to giving high vegetative growth. The results of this study agreed with those obtained by [15]. who observed an increase in the number of tomato leaves when using a fermented media for a mixture of mushroom and cow residues.

The type of growth media had a significant effect on the number of leaves of tomato plants, as it is clear from the figure that the treatment of growth medium (1 animal manure : 1 soil) and the liquid Wey treatment outperformed of the treatments with a significant difference from the treatment of growth media for animal manure only and of the treatments in addition to control treatments and for all measurement periods, the highest average number of leaves was recorded in the third stage of measurement with a value of 13 leaf plat^{-1}, while treatment (1 animal manure : 1 soil) and the dry Wey treatment recorded the lowest value with the number of leaves amounted to 11 leaf plant^{-1}, which in turn significantly outperformed the control treatments, which achieved 8 leaf plant^{-1}. These results are consistent with what [10], by obtaining a greater number of leaves of tomato plants that were sprayed Wey compared to the other treatments.

3.5. Fresh Weight of Shoot Part (gm plant^{-1})

The results of table (4) show that there is a significant effect ($P<0.05$) of adding Wey by the liquid and dry on the fresh weight of the shoot and root parts of tomato seedlings, with a significant difference of 75 % addition liquid Wey treatment compared with other treatments was attained 6.99 gm plant^{-1} for shoot part compared with control treatment and 25 % addition liquid Wey treatment, which achieved an average fresh weight of 0.56 and 3.97 gm plant^{-1}, respectively, with an increase of 114.8 and 76.07%, respectively.

As for the effect of the growth media and the type of fertilizer added, it is clear from the table that the treatment (M1T1) by apply animal manure treated with liquid Wey achieved the highest average fresh shoot weight of tomato plants with a value of 6.73 gm plant^{-1} with a significant difference from the other treatments, followed by the treatment (M2T1) by apply 1 volume of animal manure : 1 volume of soil treated with liquid Wey, which achieved of 5.97 gm plant$^{-1.}$

The reason for this is due to the final weight of the shoot part, which is the result of the increase and improvement of vegetative growth characteristics, which included plant height, number of branches, stem diameter and leaf area [16], and this was confirmed by [15], in his study on tomato plants as well as the results obtained by[10], by increasing the fresh weight when treating tomato plants by spraying them with liquid Wey.

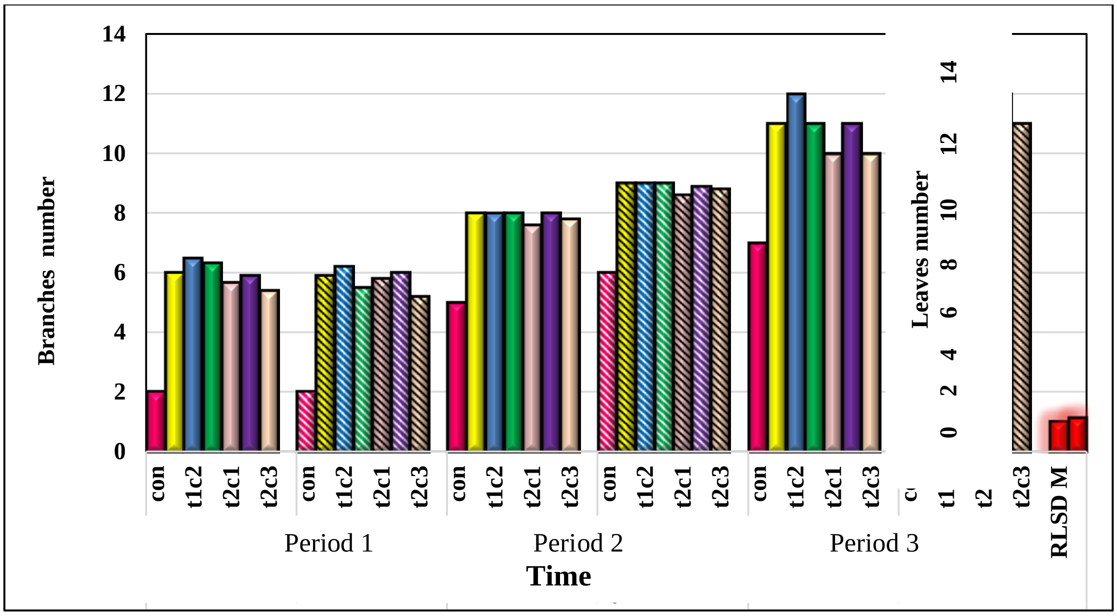

Figure 4. Effect of levels and type of Wey on the growth media on leaves number.

3.6. Fresh Weight of Roots Part (gm plant^{-1})

The results of Table (4) also show that there is a significant effect ($P<0.05$) of adding Wey in liquid and dry fresh weight of the roots parts of tomato seedlings , where the treatments to which liquid Wey was

Table 4. The effect of adding liquid and dry Wey on fresh weight of shoot and roots part (gm plant^{-1}) at the end of the experiment.

Treatment / Concentration			C1	C2	C3	Mean
Shoot part	Control T1	2.21	-	-	-	0.73c
	Control T2	1.17	-	-	-	0.39c
	M1T1	-	4.80	7.68	7.71	6.73a
	M1T2	-	3.75	5.70	6.78	5.41b
	M2T1	-	4.02	6.87	7.04	5.97b
	M2T2	-	3.33	5.69	6.43	5.15b
Mean		0.56c	3.97b	6.48a	6.99a	
Roots part	Control T1	0.02	-	-	-	0.006c
	Control T2	0.01	-	-	-	0.003c
	M1T1	-	0.10	0.14	0.23	0.156a
	M1T2	-	0.10	0.12	0.16	0.126b
	M2T1	-	0.09	0.10	0.20	0.130b
	M2T2	-	0.08	0.11	0.15	0.113b
Mean		0.005c	0.016b	0.078b	0.123a	

Apply at a concentration of 75% outperformed of the other treatments , as it reached an average the fresh weight of the roots part is 0.123 gm plant^{-1}, with a significant difference from the control treatment and the two treatments of 25 and 50% addition of Wey, which achieved an average fresh weight of 0.005, 0.016 and 0.078 gm of plant^{-1}, respectively, with an increase of 236.0, 66.8 and 57.6%, respectively.

As for the effect of growth media and the type of fertilizer added, it is clear from the table that the treatment of (M1T1) by adding animal manure treated with liquid Wey achieved the highest average fresh weight of the roots part of tomato plants with a value of 0.156 gm plant^{-1} with a significant difference from the other treatments, followed by the treatment of (M2T1) by adding 1 volume of animal manure : 1 volume of soil and the liquid Wey treatment that achieved an average fresh weight of the roots part of 0.130 gm plant^{-1}.The reason may be attributed to the fact that adding Wey to the agricultural media provided a suitable media for growth because it contains important nutrients for plant growth, which led to improving the physical properties of the soil, as well as the ability of Wey to retain water, which helped the roots to grow and increased distribution . This was confirmed by [2], that the availability of nitrogen, phosphorous and potassium elements in the vicinity of the roots by adding organic fertilizers and building a vegetative system enables the plant to carrying out various vital activities leads to the accumulation of nutrients and their transfer to the parts of the plant, which is positively reflected on the root part as it is an inverted image of the vegetative part, similarly, [18], mentioned that poultry manure increased the NPK availability in soil, promoting growth.

3.7. Dry Weight for Shoot Part (gm plant^{-1})

Results in Table (5) show that adding Wey has a significant effect on shoot dry weight of tomato seedlings. The treatments that apply liquid Wey to the planting media at a concentration of 75% were superior to the other treatments, where the average dry weight of shoot part was 0.59 gm plant^{-1}, significantly superior to the other treatments and the two control treatments (without adding Wey), the averages were 0.04 and 0.02 gm plant^{-1}, respectively.

The reason may be attributed to the role of nitrogen in the Wey protein and some minor elements in the composition and formation of the chlorophyll molecule, and then the increase in the plant's ability to carry out photosynthesis, which leads to an increase in dry weight as a result of the manufacture and accumulation of nutrients, or it may be attributed to the role of nitrogen in increasing the plant's ability to absorb mineral elements and their accumulation, especially potassium, as a result of the increase in the size of the roots, which was reflected positively on the increase in the leaf surface area and the height of the plant, as well as on increase in chlorophyll pigment, which contributed to the activity of photosynthesis, leading to an increase in the fresh weight of the shoot (Table 4). These results are consistent with what was obtained[10], an increase in the dry weight of the shoots of tomato when spraying Wey with a concentration of 50% on the shoots in doses during the growing season.

As for the effect of the growth media, the results in table (5) show that the treatment of the growth media of animal manure only and liquid Wey achieved a dry weight of 0.59 gm plant^{-1} with a significant difference from the other treatments of the other growth media (animal manure : soil).

3.8. Dry Weight of Roots Part (gm plant^{-1})

The results of table (5) show that Wey had a significant effect on increasing the dry weight of the roots part of tomato plants, where the average weight in the control treatment was 0.005 gm^{-1} for each of the tomato samples grown in the growth media and when the addition of liquid Wey was increased at concentrations of 25, 50 and 75%. The average dry weight increased to 0.015, 0.020 and 0.037 gm plant^{-1}, respectively, and significantly superior to the control treatment. These results were identical with the results obtained when calculating the roots fresh weight, where there was a superiority of liquid Wey at a concentration of 75% over the rest of the treatments.

Table 5. The effect of adding liquid and dry Wey on dry weight of shoot and roots part (gm plant^{-1}) at the end of the experiment.

Treatment / Concentration			C1	C2	C3	Mean
Shoot part	Control T1	0.12	-	-	-	0.03d
	Control T2	0.08	-	-	-	0.02d
	M1T1	-	0.52	0.59	0.66	0.59a
	M1T2	-	0.49	0.52	0.59	0.53b
	M2T1	-	0.42	0.45	0.60	0.52b
	M2T2	-	0.40	0.48	0.53	0.47c
Mean		0.05c	0.45c	0.53b	0.59a	
Roots part	Control T1	0.01	-	-	-	0.003
	Control T2	0.01	-	-	-	0.003
	M1T1	-	0.02	0.03	0.05	0.03a
	M1T2	-	0.01	0.02	0.04	0.02b
	M2T1	-	0.02	0.03	0.04	0.03a
	M2T2	-	0.01	0.02	0.03	0.02b
Mean		0.005c	0.015b	0.020b	0.037a	

As for the effect of the growth media , it is clear from the results of Table (5) that the treatment of growth media for animal manure: soil achieved the highest rate in the dry weight of the roots part with a value of 0.3 g plant^{-1}, and the treatment with liquid or dry Wey with a significant difference from the other growth media.

Conclusions

- Increased apply to 75 % liquid Wey and to 4 % dry Wey , caused a significant increasing on **:** plant height , steam diameter , branches number , leaves number , fresh and dry shoot and roots of tomato plants .
- Mixed liquid or dry Wey at one volume to on volume soil , effected a significant increasing on **:** plant height , steam diameter , branches number , leaves number , fresh and dry shoot and roots of tomato plants .
- Used liquid Wey effect a significant morphological properties of tomato plants at end of experiment compared with apply dry Wey .

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