Tomato (Solanum esculentum L.) growth under compost application. The case of climate-smart agriculture in Iraq

Mohsin Abdulhay Desher
Soil Sciences and Water Resources Department College of Agriculture University of Basrah, Iraq, mohsen.disher@uobasrah.edu.iq

Salwa Jumaah Fakhir
Soil Sciences and Water Resources Department College of Agriculture University of Basrah, Iraq, Salwa.fakher@uobasrah.eud.iq

Karrar Mahdi
Soil Physics and Land Management Group, Wageningen University & Research,6700 AA Wageningen, The Netherlands

Heman Abdulkhaleq A. Gaznayee
Department of Forestry, College of Agriculture Engineering Science, Salahaddin University, Erbil 44003, Kurdistan Region, Iraq, Heman.ahmed@su.edu.ard

Esperanza Huerta Lwanga
Soil Physics and Land Management Group, Wageningen University & Research,6700 AA Wageningen, The Netherlands
Agroecologia. El Colegio de la Frontera Sur, Unidad Campeche. Campeche, Mexico

Abstract

Tomato is one of the most important crops in Basra, Iraq. However, tomato production is affected by the impact of climate change e.g., salinity increase and intense drought. Therefore, to ensure sustainable high production and to adapt to the impact of climate change, climate-smart agriculture is introduced. A pot experiment under greenhouse conditions was conducted at winter season in 2021 at the agricultural research station College of agriculture - Basrah university (Garmat Ali campus).This study aimed to test the effect of applying 3 different organic residuals (Palm trunk, Corn molasses and Plants residue(PR),Wheat straw(As compost on growth of tomato plant (Solanum esculentiumL.), (Fotoon) properties. The organic residuals were composted. The (PR)(PR) were collected and then cut into small pieces of a size of 3cm, then each of these residues was placed separately in concrete basins dimensions 3*6m (length*width) 1.5 mm high, lined with polyethylene to prevent the effect of salt, then it was moistened until saturation and then covered with plastic for the purpose of Encouraging reactions to speed up the decomposition process, and the waste was stirred every week for the purpose of moisture homogeneity)for 2 months and mixed with three soil types at different proportions (silty clay, clay loam and sandy loam). At the pot level tomato plant experiment in complete randomized block was installed with twelve treatments and 3 replicates each. The results showed that palm trunk residues gave a significant effect on plant height growth (39.88 cm) which standard deviation was (18.64), leaf number (9.41 leaf plant-1) as standard deviation was recorded 0.69, steam diameter (0.14cm) with the standard deviation (0.0006), fresh shoot weight (32.20 gm pot-1) its standard deviation (27.64), dry shoot weight(4.38 gm pot-1) with the standard deviation (0.66) N-concentration (18.21 gm kg-1) which standard deviation was (27.95), and P-concentration (3.51 mg Kg-1) in plant tissue attain as the standard deviation was (0.30) . Moreover, silty clay soil had a significant effect on growth properties of tomato plant height, leaves number, steam diameter, fresh shoot weight, dry shoot weight, N and P-concentration in plant tissue respectively. Same results of binary between palm trunk and apply level of 25% soil + 75% compost on plant height(45.77cm) leaves number (11.66 leaf plant-1) steam diameter(0.20 cm) fresh shoot weight (47.05 gm pot-1) dry shoot weight(5.49 gm pot-1) N and P-concentration was attain values (22.16 g kg-1 and 4.85 mg kg-1), were recorded respectively.

Keywords: *Pots, soil textures, Palm trunk Date-compost, Corn molasses, Tomato (Solanum esculentium L.)*

1. INTRODUCTION

Tomato crop (T.C), (Solanum esculentum L.) is one of the most important vegetable crops in the entire world, due to its high nutritional value, each 100gof the fruit contains 100 units of vitamin A, 0.06 mg of vitamin B1, 0.04 mg/m of vitamin B2, 0.7 mg/m of vitamin B3 and 10-26 mg of vitamin C with 13 mgm-1 calcium, 27 mg phosphorus, 244 mgm-1potassium and 0.5 mg/m, iron reading tomato in different environmental conditions has produced the selection of the best hybrid variety growing warm dry, with high quality and yield [1]. Given the importance of the(T.C)s, it is necessary to improve the cultivation of this crop in Iraq. Organic fertilizers consider as alternative to used organic fertilizers due to its characteristics and rolls on growth, yield and leaves plant contents of nutrient elements without any significant difference between organic and chemical fertilizers and have low content of nitrate with best quality properties compared with using chemical fertilizers [2].

Organic fertilizers (compost) are considered as the best soil life enhancers due to nutrient elements and organisms that can benefit and be useful to encourage plants for good growth [3]. Organic fertilizer extract contains several organic soluble components such as: sugars, proteins and organic acids that can contribute directly or non-directly on plant growth [4]. Different sources of organic fertilizers showed many properties in its efficiency and activity to provide nutrients to soil depend on methods of preparing, used, soil characteristics and plant varieties [5].Given that Iraq contains very large quantities of date palm waste, the amount amounted to approximately15.3 million [6]. The quantities of date palm waste are estimated seasonally in the world at about 4.5 million tons[7]. which are almost useless and that leaving them in the field or destroying them by traditional methods such as burning causes damages environment and raise pollution rates. In order to reduce this damage and turn it into benefits that generate returns that can be used. As an organic fertilizer after partially decomposing it and benefiting from it in improving soil properties and increasing Its content is organic matter.

The organic matter of plant wastes compost is one of best nutrition system that can effect positively on physical, chemical and biological soil properties and plant growth [8]. However, this type of compost fertilizer supplies nutrients such as N, P and K as well as micronutrients to the soil[9], in addition to improved soil properties such as: increased holding irrigation water, decreased soil pH and E.C. Improving soil conditions to encourage crops increased growth and total yield, need to conduct new methods in nutrition and fertilizer when it adding at the right way and demanded by plants

[10], Because the soil in south of Iraq especially in Basrah was calcaoures soils , so its infertility and have a poor physical and chemical properties such as low organic matter content, higher pH and higher salinity content depend on drought and salinity in soil and water irrigate plants , its caused field or low growing plants due to decreased organic matter and available nutrient minerals in soil solution , and at the end its effect on growth and total yield[11].

Tomato plants are classified as moderately sensitive for salinity, that is, tolerant of salinity up to 2.5ds m-1 without production loss. An increase in salinity higher than this percentage negatively affects the growth of the yield of the tomato plant, as salinity is one of the factors. The main environmental determinant of plant growth and yield parade), because of its direct negative effects (toxicity and osmosis) on the plant, which leads to changes in the physical and biochemical processes in the plant that lead to reduced growth and plant yield and reduced construction process efficiency photosynthesis, respiration and element readiness [12]. It was found (Al-Yahyai.,2010)[13], that the growing tomato in irrigated sandy soils with salinity levels of 3 and 6 dsm-1. It gave the highest yield while the salinity level was 9 dsm-1 reduce the number and weight of fruits. The effect of salinity on plant growth and yield depends on several factors, including varieties, weather conditions and cultivation method. Therefore, one of the ways to overcome the problem of salinity is to use salt-tolerant varieties.

Organic matter has a role in improving the physical properties of soil related to permeability and porosity, movement of water and air in the soil, root spread and penetration, and soil moisture and heat retention, as for the role of organic matter in influencing the chemical properties of the soil, it revolves around increasing the cationic exchange capacity of the soil and its action as a chelating substance that limits the loss and deposition of nutrients[14].

The aim of this study was to select the appropriate kind of organic compost fertilizers made with agro-wastes and used as environmentally friend media with mixed with different type of soil on (TC) (Solanum esculentum L.) growth and yield and decreased negative effect of organic residuals on environment and used it in smart agriculture field under greenhouse conditions.

2. Materials and Methods

A pot experiment was conduct in the green house at College of Agriculture, University of Basrah , Garmat Ali region , during the winter season 2021 to study the effect of three kinds of compost organic fertilizers (Poultry, cattalo and corn residues) in addition to control and three texture soils on growth of tomato plant (Solanum esculentium L.). The experiments was carried out using soil textures' :

a) Light texture soil, collected from Al-Zubier region, about 35 Km west from Basrah city, classified as torripassment type, characteristics showed in (Table 1).

b) Medium texture soil, collected from AL-Qurna region about 80 Km north of Basrah city, and classified as typictorrifluvents, characteristics showed in (Table 1).

c) Heavy texture: soil, collected from Al-Medayna region about 90 Km North west of Basrah city, classified as typictorrifluvents, characteristics showed in (Table1).Each soil was air-dried, ground, pass through 4 mm sieve for big stones, and then again through2 mm sieve: three replicates were taken for initial properties. As follows and data presented in (Table1).

Table 1

Soil	E.C (dSm^{-1})	pH	Avail. N (ppm)	Avail. P (ppm)	Avail. K (ppm)	O.M gm Kg $soil^{-1}$	Clay %	Silt %	Sand %	Bulk density Meg gm/m^3
Silty Clay	4.27	7.95	0.62	62.30	398.00	9.66	40.39	31.05	28.56	1.35
Sand	2.50	7.85	0.37	47.24	72.00	0.60	7.17	5.22	87.62	1.65
Silty	4.33	7.35	0.56	49.98	271.00	13.20	9.44	87.39	26.30	1.44

1) Physical and chemicals analysis on the above.

Physical and chemicals analysis were determined on the above soils, and are present in Table 2: I measured Soil pH, Electric conductivity:(E.C), Organic matter (O.M),Available , N Available , P Available K. According to the method mentioned in Page et al, [15].Total N,P and, K: Organic compost was digestion with $HClO_4+H_2SO_4$ mixes as described by Cresser and parsons, [16]. Total N was evaluated by micro Kjeldahl procedure Bremner ,[17].Total P and total K was evaluated in the digest as followed in soil. Total Mg was quantified using atomic absorption spectrophotometer.

2) Compost type and doses.

Composted of (P.R)s were collected from different farmers' fields of Basrah province and air drying for one month and grinding to get very fine powder, Al-Abdely ,[18]. Table 2 showed some chemical and physical properties of (P.R) s before and after composting for three samples and used in experiment.

Two different compost doses were used: 0% (Non application) and 5 % W: W based on soil dry weight.

Table 2. Some physical and chemical properties of compost used in experiment.

	Date palm trunk compost		**Plant stems and leaves Compost**		**Corn molasses compost**	
Properties	Before	After	Before	After	Before	After
pH	7.2	7.1	7.3	7.1	7.2	7.0
E.C dSm^{-1}	9.00	9.54	10.25	11.00	6.21	5.62
O. C (gkg^{-1})	226.50	236.61	311.14	327.40	66.12	74.55
Total N(gkg^{-1})	6.52	11.12	20.11	24.20	12.55	13.15
Total P(gkg^{-1})	9.81	11.14	13.43	17.16	11.6	12.11
Total K(gkg^{-1})	7.14	7.20	5.12	5.36	2.51	2.72
O.M %	142.69	149.05	196.01	206.26	41.65	46.93

2.1. Experimental lay out:

The experiment was settled in complete randomized design. for each crop type and three replicates per treatment with a total of 54 experimental units (3 soil types X3 kind of compost X2 doses X1 crop X3 replicates). Five Kilograms of soil was introduced in each 18X 20 Cm plastic pots of size. organic compost was applied at rate of 0 and 250 g pot-1, equivalent to 0 and 5% based on soil dry weight, respectively in 1st of April 2021. Ten seeds of hybrid tomato (Solanum esculentium L.), (Foton variety) were sown at 15th September ,2021 and later thinned to plant plants per pot after 15 days from germination under greenhouse conditions. The plants received nitrogen, phosphorus and potassium according to crop recommendations as NPK (12-12-17) fertilizer during the trial period. NPK fertilizers was mixed with upper layer of soil in pots at sowing time. The plants received normal agricultural practices recommended for them all over crops growth period. Some irrigation water properties are presented in (Table 3):

Table 3. Irrigation water analysis used in pot experiment

E. C (dSm^{-1})	pH	SO4 (ppm)
0.344	7.44	0.08

At the end of trial (After 40 days of germination –1st November 2021), morphological measurements were taken on plants for all treatments. After that plants were harvested by cutting shoot parts above the soil surface, placed into labeled bags, then fresh weights were recorded. After that, plant samples cleaned and oven dried at 70°C for 48 hours and dry weights were recorded. The oven dried samples were ground, passes through 1mm sieve ,then 0.2 g was taken for digestion in 10 ml of 1:3 (HCLO4:HNO3) mixture at 200C total N,P and K was determined in plants tissue as previously.

2.1.1 Assessments:

At the end experiment, many properties were measured as below:

I. Vegetative growth parameters: Plant height (cm),Leaf area (cm2),leaves number (leave plant-1)

II. Plant chemical properties: Total N percentage (%), Total P percentage (%).

2.1.2 Statistical analysis:

The analysis of variance (ANOVA) was performed with the data of all treatments the effect of main factors, (soil type, compost and application rate, compost dose) and their interactions, plant and soil end points using Gen Stat procedure library release pL 18.2. The revised least significant difference was calculated at 0.1 level of significant F test.

3. Results

3.1 Plant height (cm)

The results in Table 4 and the statistical analysis showed that the type of (PR)s, the level of their combinations, soil texture, and the interaction between them had a significant effect on plant height of(T.C).Table 4 shows a significant effect of the type of (PR)s on plant height of tomato crop, it was the highest value 39.88cm for palm stems residues and less value 32.05 cm corn residues. The results of Table 4 show that there is a significant effect of soil texture on plant height of(T.C), as it is noted from the table that the texture of the silty clay soil gave the highest average height of (37.46 cm), while there were no significant differences between the clay and sandy textures, where their rates reached (34.60 and 34.26 cm) sequentially. It may be due to the role of (PR)s added to the soil in increasing soil fertility and providing it with nutrients through the role of organic fertilizers to improve the physical properties and increase the readiness of the major and minor elements necessary to carry out the vital processes inside plants [18]. The increase in the levels of (P.R) s led to a significant increase in the plant height of the (T.C), as its rates reached (41.46, 38.10 and 34.96 cm) compared to the control treatment

(27.25 cm), with an increase of 28.3, 39.8 and 52.1% over the control treatment. These results agree with [19], who found a significant increase in plant height of 12.2 cm compared to the control treatment, which reached 9.15 cm. Muslat (2015) [8], identified the advantages and benefits of organic fertilizers as increasing the soil's ability to retain water, especially sandy soils, and improving soil construction, which in turn leads to better ventilation and drainage, which helps in the movement of water, washing salts from the soil, and an important source of many nutrients necessary for plants and activating microorganisms in the soil. The binary interaction coefficients in Table 4 between the type of (PR)s and soil texture showed that there were significant differences in plant height for (T.C). The treatment of palm trunks residues and silty clay soil texture gave the highest value for plant height (42.49 cm), while it showed the lowest value for plant height at plants residue and sandy soil texture attain (31.72 cm).

The results of Table 4 showed the case of he between the type of (P.R) s and their added levels, which recorded a significant effect on the plant height rate of (T.C), and the highest value was when treating palm trunks residues and at the level of 75% compost + 25% soil, and it reached (45.77 cm), and the lowest value at plants residue and the control level amounted to 22.55 cm. The results in Table 4 of the statistical analysis showed the significant effect of the interaction between soil texture and the levels of (PR)s on the plant height of the (T.C). The silty clay soil at the level 75% compost + 25% soil gave the highest value for plant height, which was 43.88 cm. The lowest value at the sandy texture and at the control level was 26.77 cm.

The triple interaction between the type and levels of (PR)s and soil texture had a significant effect on the plant height of tomato yield. Table 4 indicate that the treatment of palm trunks residues and the level of 75% compost + 25% soil and silty clay soil texture gave the highest height and reached 53.0 cm, while the lowest value appeared at plants residue and control treatment in sandy loam soil texture, where it reached 16.66 cm [20].

Table 4. Effect of compost type and soil textures on Plant height (cm)

Soil texture	Levels	(P.R) Date palm trunk	Corn molasses	Plant stems and leaves	Soil texture X levels
Silty clay north of Basrah	Control	33.33	26.00	30.00	29.77
	25 % compost + 75 % soil	41.00	34.66	36.33	37.33
	50 % compost + 50 % soil	42.66	34.66	39.33	38.88
	75 % compost + 25 % soil	53.00	36.00	42.66	43.88
Clay loam east of Basrah	Control	35.66	19.00	21.00	25.22
	25 % compost + 75 % soil	37.00	26.00	36.33	33.11
	50 % compost + 50 % soil	39.33	36.00	38.00	37.77
	75 % compost + 25 % soil	43.00	41.66	42.33	42.33
Sandy loam west of Basrah	Control	35.66	28.00	16.66	26.77
	25 % compost + 75 % soil	36.33	31.66	35.33	34.44
	50 % compost + 50 % soil	40.33	34.66	38.00	37.66
	75 % compost + 25 % soil	41.33	36.33	36.90	38.18
Average (P.R)					

(P.R)X Soil texture	date palm trunk	42.49	38.74	38.41	39.88
	corn molasses	32.83	30.66	32.66	32.05
	plant stems and leaves	37.08	34.41	31.72	34.40
	Average soil texture	37.46	34.60	34.26	-----
Average Levels					
(P.R)X Levels	Control	34.88	24.33	22.55	27.25
	25 % compost + 75 % soil	38.11	30.77	35.99	34.96
	50 % compost + 50 % soil	40.77	35.10	38.44	38.10
	75 % compost + 25 % soil	45.77	37.99	40.63	41.46

LSD 0.05

(P.R)	Levels	Soil texture	(P.R)X Levels	(P.R)X Soil texture	(P.R)X Soil texture	(P.R) X levels X Soil texture
0.86	1.06	1.05	1.49	1.50	1.82	2.11

3.2. Leaves numbers(Leaf plant-1)

The Table 5 shows a significant effect of the type of (PR)s on the number of leaves of the tomato crop. It was the highest value9.41Leaf plant-1for palm trunks residues and less value8.0Leaf plant-1corn residues. The results of Table 5 show that there is a significant effect of soil texture on tomato plant leaves, as it is noted from the table that the texture of silty clay soil gave the highest number of leaves attain to 9.25 Leaf plant-1, while the number of leaves for sandy loam soil was 8.33 Leaf plant-1 and clay loam soil was 8.08 Leaf plant-1. The increase in the levels of plants residue led to a significant increase in the number of leaves of the (T.C), as its rates reached 7.88, 8.99 and 10.32 Leaf plant-1 compared to the control treatment 6.44 Leaf plant-1, with an increase of 22.36, 39.59 and 60.24% over the control treatment.

The binary interaction coefficients in Table 5 between the type of (PR)s and soil texture showed that there were significant differences in the number of plant leaves for the (T.C). The treatment of palm trunks residues and silty clay soil texture gave the highest value for plant leaves 10.00 Leaf plant-1, while it showed the lowest value of leaves at plants residue and clay loam soil to reach 7.25.Leaf plant-1. These results are in agreement with Al-Zawba'i [19] who found a significant increase in plant leaves that reached 7.3 Leaf plant-1compared to the control treatment which amounted to 4.5 Leaf plant-1. Results in Table 5 showed the bilateral interaction between the type of (PR)s and their added levels, which recorded a significant effect on the average number of plant leaves for the tomato crop, highest number was at treatment of date palm trunk with level 25% soil + 75% compost was attain 11.66 Leaf plant-1.

The lowest value was at (PR)s and control treatment amounted to 5.66 Leaf plant-1. The results also showed in TableS5 for the statistical analysis the significant effect of the interaction between soil texture and the levels of (PR)s in the number of tomato plant leaves. The silty clay soil at the level of 75% compost + 25% soil gave the highest value for the number of leaves, which amounted to 12.0 Leaf plant-1 and was less value at the sandy loam, clay loam textures and at the control level was 6.0 Leaf plant-1. The triple interaction between the type and levels of (PR)s and soil texture had a significant effect on the number of leaves of the (T.C) plant Table 5. The treatment of palm trunks residues and the level of 75% compost + 25% soil and silty clay soil gave the highest number and reached 11.0 Leaf plant-1, while the lowest value appeared at (PR)s and control treatment in clay loam soil where it reached 4.0 Leaf plant-1.

Table 5. Effect of compost type and soil textures on Leaves numbers.

Soil texture X Levels	Levels corn molasses plant stems and leaves	(P.R) date palm trunk	soil texture
Silty clay north of Basrah	Control	6.00	7.00
	25 % compost + 75 % soil	10.00	7.00
	50 % compost + 50 % soil	10.00	10.00
	75 % compost + 25 % soil	14.00	13.00
Clay loam east of Basrah	Control	8.00	4.00
	25 % compost + 75 % soil	8.00	6.00
	50 % compost + 50 % soil	11.00	7.00
	75 % compost + 25 % soil	11.00	12.00
Sandy loam west of Basrah	Control	6.00	6.00
	25 % compost + 75 % soil	9.00	8.00
	50 % compost + 50 % soil	10.00	6.00
	75 % compost + 25 % soil	10.00	9.00

diameter (cm)

Table 6 shows a significant effect of the type of (PR)s on the stem diameter of the(T.C), it was 0.14 cm for palm trunk residues, while there was no difference between corn residues and(PR)s, it reached 0.13 cm for both treatments. This is due to the high content residues of acids that increase the readiness of the elements for the plant in the soil, which is reflected on the growth represented by an increase in the diameter of the stem [4].The results of Table 6 show that there is a significant effect of the soil texture on the stem diameter of the (T.C), as it is noted from the table that silty clay soil texture gave the highest stem diameter (0.15 cm), while the stem diameter for clay loam soil was (0.13 cm) and sandy loam soil (0.12 cm). The increase in the levels of (P.R) s led to a significant increase in the stem diameter of the (T.C), as its rates were (0.12, 0.15 and 0.16 cm) compared to the control treatment (0.10 cm) respectively, with an increase of 20, 50 and 60% compared to the control treatment respectively.

The binary interaction coefficients as showed in Table 6 between the type of (P.R)s and soil texture showed significant differences in the stem diameter of the(T.C). The treatment of palm trunk residues and the silty clay soil texture gave the highest stem diameter of the plant (0.17 cm), while it showed the lowest value of the plant diameter at corn residues and sandy loam soil to reach (0.10 cm). The results of Table 6 showed the case of the bilateral interaction between the type of (P.R) s and their added levels, which recorded a significant effect on the average plant diameter of tomato, and the highest value was when treating palm trunks residues and at the level of 75% compost + 25% soil (0.17 cm), and the lowest value at corn residues and the control level amounted to

(0.10 cm). The results in Table 6 of the statistical analysis showed the significant effect of the interaction between soil texture and levels of (P.R)s in the stem diameter of the (T.C). Silty clay soil at the level of 75% compost + 25% soil gave the highest value of stem diameter and reached 0.20 cm and the lowest value was at the sandy loam and clay loam textures and at the control level, was attain 0.10 cm. The triple interaction between the type and levels of (PR)s and soil texture had a significant effect on the stem diameter of the (T.C) plant Table 6showed the treatment of palm trunk residues and the level of 75% compost + 25% soil and silty clay soil gave the highest stem diameter and reached 0.20 cm, while the lowest value appeared in the treatment of (PR)s and control treatment at clay loam texture, which amounted to 0.10 cm.

Table 6. Effect of compost type and soil textures on steam diameter (cm).

Soil texture	Levels	(P.R)			Soil texture X Levels
		Date palm trunk	corn molasses	Plant stems and leaves	
Silty clay north of Basrah	control	0.13	0.10	0.10	0.11
	25 % compost + 75 % soil	0.16	0.13	0.10	0.13
	50 % compost + 50 % soil	0.20	0.20	0.16	0.18
	75 % compost + 25 % soil	0.20	0.20	0.20	0.20
Clay loam east of Basrah	control	0.10	0.10	0.10	0.10
	25 % compost + 75 % soil	0.10	0.13	0.10	0.11
	50 % compost + 50 % soil	0.16	0.13	0.13	0.14
	75 % compost + 25 % soil	0.16	0.16	0.13	0.15
Sandy loam west of Basrah	control	0.10	0.10	0.10	0.10
	25 % compost + 75 % soil	0.13	0.10	0.10	0.11
	50 % compost + 50 % soil	0.13	0.10	0.13	0.12
	75 % compost + 25 % soil	0.16	0.10	0.13	0.13
Average (P.R)					
(P.R)×soil texture	date palm trunk	0.17	0.13	0.13	0.14
	corn molasses	0.15	0.13	0.10	0.13
	plant stems and leaves	0.14	0.12	0.12	0.13
	Average soil texture	0.15	0.13	0.12	-----
Average Levels					
(P.R)×Levels	control	0.11	0.10	0.10	0.10
	25 % compost + 75 % soil	0.13	0.12	0.10	0.12
	50 % compost + 50 % soil	0.16	0.14	0.14	0.15

		75 % compost + 25 % soil	0.17	0.15	0.15	0.16

LSD 0.05						
(P.R)	Levels	soil texture	(P.R)X levels	(P.R)X soil texture	(P.R)X soil texture	(P.R)X soil texture X levels
N.S	0.0005	0.0007	0.0008	0.0008	0..0008	0.0009

3.4. Fresh Shoot weight (gm pot-1) :

Table 7 shows a significant effect of the type of (PR)s on the fresh shoot weight of the tomato crop, it was the highest value32.2gm pot-1 for palm stems residues and less value22.94 gm pot-1 corn residues. The length of the plant, the number of leaves, and the diameter of the stem, which was reflected on the fresh weight of the vegetative group. These results are consistent with what was found by [21].

The results of Table 7 show that there is a significant effect of soil texture on the fresh shoot weight of(T.C), as it is noted from the table that silty clay soil texture gave the highest wet weight of 27.77 gm pot-1, which does not differ significantly from the sandy loam texture of 27.52 gm pot-1, while the lowest wet weight was at clay loam soil texture reached 24.69 gm pot-1.The increase in the levels of (PR)s led to a significant increase in the fresh shoot weight of(T.C), as its rates reached 24.38, 31.38 and 36.96 gm pot-1, compared to the control treatment of 13.92 gm pot-1, with an increase of 75.14, 125.43 and 165.51% over the control treatment respectively. The binary interaction coefficients in table 7 between the type of (PR)s and soil texture showed significant differences in the fresh shoot weight of(T.C). The treatment of palm trunks residues and silty clay soil texture gave the highest wet weight value of 36.1 gm pot-1, while it showed the lowest wet weight value at (P.R)s and clay loam soil up to 20.58 gm pot-1.

The results of Table 7 showed the bilateral interaction between the type of (PR)s and their added levels, which recorded a significant effect on the average fresh shoot weight of the(T.C). Treatment of palm trunk residues at level 25% soil + 75% compost gave the highest value attain 47.05 gm pot-1, while the lowest value at control treatment reached 11.03 gm pot-1. The results also showed in Table 7 of the statistical analysis the significant effect of the interaction between soil texture and the levels of (PR)s on fresh shoot weight of the(T.C), silty clay soil at the level of 75% compost + 25% soil gave.

Table 7. Effect of compost type and soil textures on fresh shoot weight (gmpot-1)

Soil texture	Levels	(P.R) date palm trunk	corn molasses	plant stems and leaves	soil texture X levels
Silty clay north of Basrah	Control	9.96	9.55	10.99	10.16
	25 % compost + 75 % soil	29.45	23.96	23.15	25.52
	50 % compost + 50 % soil	49.22	24.22	25.15	32.86
	75 % compost + 25 % soil	55.82	33.20	38.62	42.54

Clay loam east of Basrah	Control	13.99	9.42	13.24	12.21
	25 % compost + 75 % soil	24.50	15.13	22.01	20.54
	50 % compost + 50 % soil	45.47	28.63	23.73	32.61
	75 % compost + 25 % soil	47.66	29.21	23.37	33.41
Sandy loam west of Basrah	Control	9.156	22.20	26.87	19.40
	25 % compost + 75 % soil	30.87	23.72	26.68	27.09
	50 % compost + 50 % soil	32.73	24.91	28.40	28.68
	75 % compost + 25 % soil	37.68	31.27	35.86	34.93
(P.R)X soil texture	date palm trunk	36.11	32.90	27.60	32.20
	corn molasses	22.73	20.59	25.52	22.94
	plant stems and leaves	24.47	20.58	29.45	24.83
	Average soil texture	27.77	24.69	27.52	--------
Average Levels					
(P.R) X Levels	Control	11.03	13.72	17.03	13.92
	25 % compost + 75 % soil	28.27	20.93	23.94	24.38
	50 % compost + 50 % soil	42.47	25.92	25.76	31.38
	75 % compost + 25 % soil	47.05	31.22	32.61	36.96

LSD 0.05

(P.R)	Levels	soil texture	(P.R)X levels	(P.R)X soil texture	(P.R)X soil texture	(P.R)X levels X soil texture
1.50	2.75	2.60	2.90	2.85	2.80	3.03

The highest value reached 42.54 gm pot-1, and the lowest value at the same texture and control treatment, reaching 10.16 gm pot-1. The triple interaction between the type and levels of (PR)s and soil texture had a significant effect on fresh shoot weight of(T.C) (Table 7). The treatment of palm trunks residues and the level of 75% compost + 25% soil and silty clay soil gave the highest value attain 55.82 gm pot-1, while the lowest value appeared at (PR)s and comparison silty clay soil was 10.99 gm pot-1.

3.5. Shoot dry weight (gm pot-1):

Table 8 shows a significant effect of the type of (P.R)s on shoot dry weight of the(T.C),It was the highest value4.38 gm pot-1 for palm stems residues and less value2.84 gm pot-1 corn residues. Increasing the absorption of water and nutrients from plant roots due to the improvement of the physical conditions and the increase in soil water retention. These results agree with the findings of Salman and [22].The increase in the production of dry matter of tomato plant can be explained by the fact that the addition of (PR)s to the soil caused an increase in the absorption of water and nutrients by the roots of the plant due to the improvement of physical conditions and an increase in soil water retention. These results are consistent with the findings of [23]. In addition, the addition of residues to the soil may have an effect on increasing the activity and numbers of microorganisms in the soil that continuously add nutrients to the soil, which restores the balance of nutrients in it Haoet al[3], works to improve soil porosity and regulate the movement of water and air in it, the organic fertilizers heat the root growth medium through the heat resulting from the decomposition of organic matter, which increases the activity of the roots in absorbing water and nutrients and positively affects the vegetative growth of the plant[24].

The results of Table 8 show that there is a significant effect of soil texture on the shoot dry weight of(T.C). It is noted from the table that the sandy loam soil texture gave the highest dry weight of 3.67 gm pot-1, which did not differ significantly from the silty clay soil texture of 3.63 gm pot-1, while the lowest dry weight was for clay loam soil texture, reached 3.42 gm Pot-1. The increase in the levels of (PR)s led to a significant increase of shoot dry weight of(T.C), as its rates reached 3.22, 3.96 and 4.66 gm pot-1, compared to the control treatment of 2.45 gm pot-1 respectively, with an increase of 31.42, 61.63 and 90.20% over the control treatment respectively. The binary interaction coefficients in table 8 between the type of (P.R)s and soil texture showed that there were significant differences in the shoot dry weight of(T.C). The treatment of palm trunks residues and silty clay soil texture gave the highest value for plant height of 5.17 gm pot-1, while the lowest value of shoot dry weight was shown at corn residues treatment for same texture attain to 2.19 gm pot-1.

The results of Table 8 showed the case of the bilateral interaction between the type of (PR)s and their added levels, which recorded a significant effect on the average shoot dry weight of the(T.C). Highest value was recorded at palm trunk residues treatment with 25% soil + 75% compost attain 5.49 gm pot-1, the lowest shoot dry weight was at treatment of corn residues and the control level amounted to 2.07 gm pot-1. The results and statistical analysis showed a significant effect of the interaction between soil texture and levels of (PR)s on shoot dry weight of the(T.C), silty clay soil texture at the level of 75% compost + 25% soil gave the highest dry weight value. It reached 4.89 gm pot-1, and the lowest value at the sandy loam and clay loam texture soils and control treatment, reaching 2.53 gm pot-1.

The triple interaction between the type and levels of (P.R)s and soil texture had a significant effect on shoot dry weight of(T.C). Treatment of palm trunk residues and the level of 75% compost + 25% soil and silty clay soil gave the highest dry weight of 6.30 gm pot-1, while the lowest value appeared at plants residue and control treatment on clay loam soil, which amounted to 2.30 gm pot-1.

Table 8. Effect of compost type and soil textures on dry weight (gm pot-1)

Soil texture	Levels	(P.R)			
		Date palm trunk	Corn molasses	Plant stems and leaves	(P.R)X levels
Silty clay north of Basrah	Control	2.57	1.31	2.93	2.27
	25 % compost + 75 % soil	5.54	1.34	3.06	3.31
	50 % compost + 50 % soil	6.27	2.69	3.21	4.05

	75 % compost + 25 % soil	6.30	3.45	4.92	4.89
Clay loam east of Basrah	Control	2.30	2.98	2.43	2.57
	25 % compost + 75 % soil	3.50	2.70	2.42	2.87
	50 % compost + 50 % soil	4.37	2.86	3.80	3.67
	75 % compost + 25 % soil	5.38	3.88	4.48	4.58
Sandy loam west of Basrah	Control	3.00	1.92	2.67	2.53
	25 % compost + 75 % soil	4.09	2.89	3.48	3.48
	50 % compost + 50 % soil	4.46	3.72	4.34	4.17
	75 % compost + 25 % soil	4.79	4.38	4.40	4.52
		Average (P.R)			
(P.R)×soil texture	date palm trunk	5.17	3.88	4.08	4.38
	corn molasses	2.19	3.10	3.22	2.84
	plant stems and leaves	3.53	3.28	3.72	3.51
	Average soil texture	3.63	3.42	3.67	
		Average Levels			
Levels×soil texture	Control	2.62	2.07	2.67	2.45
	25 % compost + 75 % soil	4.37	2.31	2.98	3.22
	50 % compost + 50 % soil	5.03	3.09	3.78	3.96
	75 % compost + 25 % soil	5.49	3.90	4.60	4.66

LSD 0.05						
(P.R)	Levels	Soil texture	(P.R) X levels	(P.R)X soil texture	Levels X soil texture	(P.R)X levels X soil texture
0.50	0.10	0.10	0.60	0.65	0.50	0.70

3.6. N - Concentration in tissue fresh shoot (g Kg-1) :

Data in Table 9 shows a significant effect of the type of plant residues on the nitrogen concentration in tomato plant tissue, it was the highest value18.21 g kg-1 for palm stems residues and less value9.32g kg-1corn residues.

This agreed with EL-Naggar [25], whose results indicated a difference in nitrogen concentration according to the type of (P.R)s. This was reflected in an increase in the soil nitrogen content (Table 1), an increase in the activity and mass of microorganisms, and an increase in the absorption of nutrients by the plant [26]. The reason for this can be explained by the difference in the C/N ratio of (P.R)s, which affects the nitrogen concentration in the vegetative system. These results are in agreement with the findings of Li et al. [27].

The results of Table 9 show that there is a significant effect of soil texture on Nitrogen content in tomato plant, it is noted from the table that sandy loam soil texture gave the highest nitrogen concentration attain 14.28 g kg-1, while the lowest nitrogen concentration at clay loam texture was 11.24 g kg-1. The increase in the levels of (P.R)s led to a significant increase in the nitrogen concentration of the(T.C), as its rates reached 12.24, 13.90 and 14.66 g kg-1 compared to the control treatment of 10.19 g kg-1, with an increase of 20.11, 36.40 and 43.86% over the control treatment respectively. The reason for the increase in nitrogen concentration can be explained by increasing (P.R)s, to the role of (P.R)s in improving the physical and chemical properties of soils, which helped to increase the retention of nitrogen granules and preserve it from loss, in addition to increasing the ability of soils to retain water and improving other soil properties. These results agreed with what was found [28].

The binary interaction coefficients in Table 9 between the type of (PR)s and soil texture showed significant differences in the nitrogen concentration in the vegetative total of the(T.C). The treatment of palm trunks residues and sandy loam soil texture gave the highest nitrogen concentration, which reached 21.93 g kg-1,while it showed the lowest value of nitrogen concentration at corn residues and clay loam soil texture to reach 8.96 g kg-1.

Table 9 showed the case of the bilateral interaction between the type of (PR)s and their added levels, which recorded a significant effect on the nitrogen concentration rate in tomato plant tissue. A highest value recorded in palm trunk residues at level: 25% soil + 75% compost attain 22.16 g kg-1, while lowest value recorded when apply corn residues and control level was 8.79 g kg-1. The results also showed in Table 9 a significant effect of the interaction between soil texture and levels of (PR)s on nitrogen concentration in tomato plant tissue, sandy loam soil texture at level of 75% compost + 25% soil gave the highest value of nitrogen concentration, amounting to 16.27 g kg-1, and the lowest value was in the clay loam soil texture and control level reached 9.15 g kg-1.

The triple interaction between the type and levels of (PR)s and soil texture had a significant effect on the nitrogen concentration in tomato plant tissue (Table9). The treatment of palm trunks residues, 75% compost + 25% soil and sandy loam soil texture gave the highest nitrogen concentration and reached 26.33 g kg-1, while the lowest value appeared at plants residue and the control treatment of clay loam soil texture, which amounted to 8.58 g kg-1. The resin of this results may be due to the role of organic residuals Table 2 added to the soil in increasing soil fertility and increasing the readiness of the major and minor elements necessary to carry out the metabolism processes inside the plant Al-Obaidi, [29] the elements play an important role in plant growth and plant bio activities, as nitrogen enters the synthesis of chlorophyll in addition to the formation of amino acids that enter into the synthesis of chloroplasts[30], and in the synthesis of proteins and nucleic acids, DNA and RNA[31] and that the abundance of this element leads to an increase in the mass of protoplasm and cell division, thus increasing the size of the vegetative system [32].

Table 9. Effect of compost type and soil textures on N-concentration (gm Kg-1) in tomato plant tissue.

soil texture	Levels	(P.R) date palm trunk	(P.R) corn molasses	(P.R) plant stems and leaves	(P.R) X levels
Silty clay north of Basrah	Control	12.37	8.75	9.61	10.24
	25 % compost + 75 % soil	18.92	9.29	9.88	12.69
	50 % compost + 50 % soil	20.21	9.62	10.96	13.59
	75 % compost + 25 % soil	21.03	9.91	12.18	14.37
Clay loam east of Basrah	Control	9.92	8.58	8.95	9.15
	25 % compost + 75 % soil	10.83	8.70	9.62	9.71
	50 % compost + 50 % soil	18.41	8.95	10.92	12.76
	75 % compost + 25 % soil	19.14	9.61	11.29	13.34
Sandy loam west of Basrah	Control	14.3	9.06	10.22	11.19
	25 % compost + 75 % soil	22.32	9.65	10.97	14.31
	50 % compost + 50 % soil	24.78	9.75	11.56	15.36
	75 % compost + 25 % soil	26.33	10.05	12.45	16.27
Average (P.R)					
(P.R)X soil texture	date palm trunk	18.13	14.57	21.93	18.21
	corn molasses	9.39	8.96	9.62	9.32
	plant stems and leaves	10.65	10.19	11.30	10.71
	Average soil texture	12.72	11.24	14.28	…..
Average Levels					
Levels×soil texture	control	12.19	8.79	9.59	10.19
	25 % compost + 75 % soil	17.35	9.21	10.15	12.24
	50 % compost + 50 % soil	21.13	9.44	11.14	13.90
	75 % compost + 25 % soil	22.16	9.85	11.97	14.66

LSD 0.05						
(P.R)	Levels	soil texture	(P.R)X levels	(P.R)X soil texture	(P.R)X soil texture	(P.R) X Levels X soil texture
0.13	0.21	0.16	0.18	0.20	0.22	0.56

3.7. P- Concentration in fresh shoot (mg Kg -1)

Table 10 shows a significant effect of the type of (PR)s on the phosphorous concentration in tomato plant tissue, it was the highest value3.51 mg kg-1 for palm stems residues and less value2.51 mg kg-1 plants residues. The resin of increased nutrients in plant tissue maybe due to apply organic matter through these residuals and content high available amount of these elements, which appeared in chemical analysis, as well as the role of organic matter in reducing the loss of nutrients by washing by adsorption on the surfaces of colloids [33], or perhaps through the formation of chelated compounds of organic acids resulting from the decomposition of the added organic matter [34],Which increases the ready elements and prevents or reduces their fixation through the formation of complexes with those elements [18],as well as the role of the organic matter on increasing the cation exchange capacity (CEC), increasing soil water retention[35],and reducing soil pH, which contributes to increasing the availability of elements and increasing their concentration in the plant.

Results of Table 10 show a significant effect of soil texture on the phosphorous concentration in tomato plant tissue, as it is noted from the table that the sandy loam soil texture gave the highest phosphorous concentration of 4.04 mg kg-1, while the lowest concentration of phosphorous at clay loam soil was 2.88 mg kg-1. The increase in the levels of (PR)s led to a significant increase in the phosphorous concentration in tomato tissue, as its rates reached 2.77, 3.19 and 3.78 mg kg-1 compared to the control treatment of 2.58 mg kg-1, with an increase of 7.36, 23.64 and 46.51% over the control treatment respectively. The binary interaction coefficients in table 10 between type of (PR)s and soil texture showed a significant difference in the phosphorous concentration in tomato plant tissue, as the treatment of palm trunks residues and sandy loam soil texture gave the highest value for phosphorous concentration attain 3.70 mg kg-1, while it showed the lowest value for the concentration Phosphorous when at (PR)s and clay loam soil texture up to 2.44 mg kg-1.

Table 10. Effect of compost type and soil textures on P-Concentration (mg Kg-1 in plant tissue).

Soil texture	Levels	(P.R) Date palm trunk	Corn molasses	Plant stems and leaves	(P.R) X levels
Silty clay north of Basrah	control	2.66	2.84	2.30	2.60
	25 % compost + 75 % soil	3.11	2.85	2.44	2.80
	50 % compost + 50 % soil	3.43	3.58	2.58	3.19
	75 % compost + 25 % soil	4.88	3.28	2.69	3.61
Clay loam east of Basrah	control	2.54	2.62	2.25	2.47
	25 % compost + 75 % soil	2.65	2.67	2.39	2.57
	50 % compost + 50 % soil	3.43	3.11	2.53	3.02
	75 % compost + 25 % soil	4.67	3.22	2.60	3.49
Sandy loam west of Basrah	control	2.79	2.82	2.45	2.68
	25 % compost + 75 % soil	3.42	2.87	2.57	2.95
	50 % compost + 50 % soil	3.60	3.75	2.66	3.33
	75 % compost + 25 % soil	5.01	4.95	2.78	4.24
Average (P.R)					
(P.R)×soil texture	date palm trunk	3.52	3.32	3.70	3.51
	corn molasses	3.13	2.90	3.59	3.21
	plant stems and leaves	2.50	2.44	2.61	2.52
	Average soil texture	3.05	2.88	4.04	
Average Levels					
Levels× soil texture	control	2.66	2.76	2.33	2.58

		25 % compost + 75 % soil	3.06	2.79	2.46	2.77
		50 % compost + 50 % soil	3.487	3.48	2.59	3.19
		75 % compost + 25 % soil	4.85	3.81	2.69	3.78

LSD 0.05						
(P.R)	Levels	Soil texture	(P.R) X Levels	(P.R) X Soil texture	Levels X Soil texture	(P.R) X Levels X Soil texture
0.007	0.005	0.009	0.01	0.01	0.03	0.05

Table 10 showed the bilateral interaction between type of (PR)s and their added levels, which recorded a significant effect on the phosphorous concentration in tomato tissue. A highest value of phosphorous concentration at palm trunk residues and 25% soil + 75% compost treatment attain 4.85 mg kg-1, while a lowest value was amounted to 2.33 mg kg-1at plants residues and control treatment. The results also showed in table S10 a significant effect of the interaction between soil texture and levels of (PR)s in phosphorous concentration in tomato plant tissue, sandy loam soil at the level of 75% compost + 25% soil gave the highest value amounted to 4.24 mg kg-1, and lowest value was at clay loam soil and the control level, which amounted to 2.47 mg kg-1.

The triple interaction between the type and levels of (PR)s and soil texture had a significant effect on the phosphorous concentration in tomato plant tissue (Table 10). The treatment of palm trunks residues, 75% compost + 25% soil and sandy loam soil texture gave the highest phosphorous concentration and reached 5.01 mg kg-1, while the lowest value appeared at (PR)s and control treatment in clay loam soil, which amounted to 2.25 mg kg-1. Phosphorous is included in the composition of some organic compounds (Table2) that have great importance in vital activities such as breathing processes, carbon metabolism and representation of carbohydrates and fatty acids Al-Sahaf,[36] in addition, applications of organic fertilizer to the soil may have an effect on increasing the activity and numbers of microorganisms in the soil that continuously add nutrients to the soil, which restores the balance of nutrients in soil [3]. Also improves soil porosity and regulates water movement and air in soil, and the organic residues increased heat in rhizosphere through the heat resulting from the decomposition of organic matter, which increases the activity of the roots in absorbing water and nutrients [24]and positively affects the vegetative growth of the plant.

4. Conclusions:

1. The palm residuals effect on increased tomato plant growth at all soil textures.

2. Mixed silty loam soil with all type of (P.R) s increased tomato growth compared with control soil.

3. Apply 75% composted (P.R) s with silty clay soil increased concentrations of Nitrogen and Phosphorous in tomato plants.

4. It is necessary to add residuals compost of palm trunk to soil.

5. It is necessary to used silty clay soil texture as a growth media to produced good seedling of tomato plants.

6. It is necessary to mixed 75% of plants residual compost with 25% silty clay soil as appropriate media to tomato plant growth.

Recommendations:

Conducting more studies for other types of organic fertilizers to obtain the best growth and production of tomato plants.

Supplementary Materials: The following are available online at www.mdpi.com/xxx/s1,

Author Contributions: Conceptualization, M.A.D., S.J.F.,.,E.H.L and K.M.; Data curation, M.A.D.; S.J.F.; K.M.; and M.A.D.; Formal analysis, M.A.D., and S.J.F; Investigation, K.M., S.J.F.; M.A.D and E.H.L; Methodology, M.A.D., S.J.F., .,E.H.L and K.M.; Resources, M.A.D., S.J.F., E.H.L., K.M and H.G.; Supervision, M.A.D., S.J.F., .,E.H.L and K.M.; Visualization, M.A.D., S.J.F., .,E.H.L and K.M.; Writing—original draft, M.A.D., and S.J.F.; Review, editing, improving, M.A.D., S.J.F.,H.G.,E.H.L and K.M . All authors have read and agreed to the published version of the manuscript.

Funding: This study has been funded by Nuffic, the Orange Knowledge Programme, through the OKP-IRA-104278 project titled “Efficient water management in Iraq switching to climate smart agriculture: capacity building and knowledge development” coordinated by Wageningen University & Research, The Netherlands and Basrah University, Iraq.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Some data in this manuscript were obtained from the Ministry of Agriculture and Water Resources, Iraq

Acknowledgments: The authors would like to thank The Wageningen University & Research, The Netherlands and Basrah University, Iraq., for their sincere assistance. We are also thankful to Nuffic, the Orange Knowledge Programme, through the OKP-IRA-104278, Wageningen University & Research, The Netherlands, the Ministry of Agriculture and Water Resources/ Water Resources Department ,for their valuable support.

Conflicts of Interest: The authors declare no conflict of interest.

Reference

Opoku, J. A. Genetic variability in tomato germplasm (Solanum lycopersicum L.) using morphological characteristics and simple sequence repeat (ssr) markers, 2016. (Doctoral dissertation, Kwame Nkrumah University of Science and Technology).

Markowicz, F., & Szymańska-Pulikowska, A. Analysis of the possibility of environmental pollution by composted biodegradable and oxo-biodegradable plastics. Geosciences,2019. 9(11), 460.

Hao, X. H., Liu, S. L., Wu, J. S., Hu, R. G., Tong, C. L., & Su, Y. Y. Effect of long-term application of inorganic fertilizer and organic amendments on soil organic matter and microbial biomass in three subtropical paddy soils. Nutrient Cycling in Agroecosystems, 2008. 81(1), 17-24.

White, R.H., Worsham, A.D. and Blum, U., Allelopathic potential of legume debris and aqueous extracts. Weed Science,1989. 37(5), pp.674-679.

5.Havlin, J. L., Beaton, J. D., Tisdale, S. L., & Nelson, W. L. An introduction to nutrient management. Soil Fertility and Fertilizers, 6th ed.; Prentice Hall: Upper Saddle River, NJ, USA, 1999. 499.

Woertz, E., Food security in Iraq: results from quantitative and qualitative surveys. Food Security, 2017.9(3), pp.511-522.

Mohammadi G.A. Effect of date palm wastes and rice hull mixed with soil on growth and yield of cucumber in greenhouse culture. International Journal of Recycling of Organic Waste in Agriculture, .2013. 2(1), 1-5.

Kirchmann, H., Thorvaldsson, G., Bergström, L., Gerzabek, M., Andrén, O., Eriksson, L.O. and Winninge, M., Fundamentals of organic agriculture–Past and present. In Organic crop production–ambitions and limitations,2009. pp. 13-37. Springer, Dordrecht.

Walker, D. J., & Bernal, M. P. The effects of olive mill waste compost and poultry manure on the availability and plant uptake of nutrients in a highly saline soil. Bioresource technology, 2008. 99(2), 396-403.

Cha-um, S., &Kirdmanee, C. Remediation of salt-affected soil by the addition of organic matter: an investigation into improving glutinous rice productivity. Scientia Agricola, 2011.68, 406-410.

Desher, M. A. The Effect of Phosphate Fertilizer Starter Solution on Growth of Two Tomato (Lycopersicon Esculentum Mill) Varieties in Sandy Soil. Al-Qadisiyah Journal For Agriculture Sciences, 2017. 7(1), 137-147.

Parida, A. K., & Das, A. B. Salt tolerance and salinity effects on plants: a review. Ecotoxicology and environmental safety, 2005. 60(3), 324-349.

Al-Yahyai, R., Al-Ismaily, S., & Al-Rawahy, S. A. Growing tomatoes under saline field conditions and the role of fertilizers. A Monograph on management of salt-affected soils and water for sustainable agriculture, 2010. 83-88.

Wan, L. J., Tian, Y., He, M., Zheng, Y. Q., Lyu, Q., Xie, R. J., ... & Yi, S. L. Effects of Chemical Fertilizer Combined with Organic Fertilizer Application on Soil Properties, Citrus Growth Physiology, and Yield. Agriculture, 2021. 11(12), 1207..

Page, A. L., Miller, R. H., &Keeny, D. R. Methods of Soil analysis part (2) 2nd (ed). Agronomy 9. Amer. Soc. Agron. Madison Wisconsin. Papanicolaou, EP (1976). Determination of cation. Exchange capacity of calcareous soils and their percent base saturation. soil Sci, 1982.121, 67-71.

Cresser, M. S., & Parsons, J. W. Sulphuric—Perchloric acid digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. AnalyticaChimicaActa, 1979. 109(2), 431-436.

Bremner, J. M., & Keeney, D. R. Determination and isotope‐ratio analysis of different forms of nitrogen in soils: 3. Exchangeable ammonium, nitrate, and nitrite by extraction‐distillation methods. Soil Science Society of America Journal, 1966.30(5), 577-582.

Creger, T. L., &Peryea, F. J. Phosphate Fertilizer Influences Phytoavailabilty Of Soil Arsenic And Lead To Apricot (Prunusarmeniaca). HortScience, 1990.25(9), 1160f-1160.

Sawan, Z. M. Plant density; plant growth retardants: Its direct and residual effects on cotton yield and fiber properties. Cogent Biology, 2016. 2(1), 1234959.

Zhang, P., Senge, M., & Dai, Y. Effects of salinity stress on growth, yield, fruit quality and water use efficiency of tomato under hydroponics system. Reviews in Agricultural Science, 2016.4, 46-55.

Ochar, K. Studies on genetic variability in agronomic and fruit quality traits among some tomato (Solanum lycopersicum L.) genotypes,2015. (Doctoral dissertation, University of Ghana).

Ali, H. M. A., & Kamal, J. A. K. Effect of Pseudomonas putida, Compost, and Humus on the Growth and Yield of Tomato. In IOP Conference Series: Earth and Environmental Science ,2022. (Vol. 1060, No. 1, p. 012013). IOP Publishing.

Hameed Madi, A., & A Kamal Al-Shibani, J. Effect of Bio and Organic Fertilizers on Pumpkin's (Cucurbita pepo L.) Leave Content of N, P, and K. Al-Qadisiyah Journal For Agriculture Sciences, 2020.10(1), 241-245.

Bidabadi, S. S., Dehghanipoodeh, S., & Wright, G. C. Vermicompost leachate reduces some negative effects of salt stress in pomegranate. International Journal of Recycling of Organic Waste in Agriculture, 2017. 6(3), 255-263.

El-Naggar, A., Lee, S. S., Rinklebe, J., Farooq, M., Song, H., Sarmah, A. K., ... & Ok, Y. S. Biochar application to low fertility soils: A review of current status, and future prospects. Geoderma, 2019. 337, 536-554.

Powlson, D. S., Brookes, P. C., Whitmore, A. P., Goulding, K. W. T., & Hopkins, D. W. Soil organic matters. European Journal of Soil Science, 2011. 62(1), 1.

Ding, Y., Liu, Y., Liu, S., Li, Z., Tan, X., Huang, X., ... & Zheng, B. Biochar to improve soil fertility. A review. Agronomy for sustainable development, 2016.36(2), 1-18.

Rasul, F., Ahmad, A., Arif, M., Mian, I. A., Ali, K., Qayyum, M. F., ... &Shackley, S. Biochar for agriculture in Pakistan. In Sustainable Agriculture Reviews ,2017. (pp. 57-114). Springer, Cham.

Alsalhy, B. F. J., &Aljabary, A. M. A. O. Effect Of Moringa Leaves Extracts And Licorice Roots On Some Growth Characteristics And Yield Of Grape (VitisVinifera L.) Cv. Halawany. Plant Archives, 2020. 20(2), 2616-2623.

Gutiérrez - Mañero, F. J., Ramos - Solano, B., Probanza, A. N., Mehouachi, J., R. Tadeo, F., & Talon, M. The plant - growth - promoting rhizobacteria Bacillus pumilus and Bacillus licheniformis produce high amounts of physiologically active gibberellins. PhysiologiaPlantarum, 2001.111(2), 206-211.

Spayd, S. E., Stevens, R. G., Wample, R. L., & Evans, R. G. Nitrogen fertilization and factors influencing grapevine cold hardiness. In Proceedings of the International Symposium on Nitrogen in Grapes and Wine: Seattle, Washington, Usa 18-19 june,1991. (pp. 120-125). American Society for Enology and Viticulture, ASEV.

Taiz, L., &Zeiger, E. Plant Physiology Sinauer Associates. Inc., 2006.Sunderland, MA.

Ret; Michael F. Allen, T. A. Z. The effects of organic amendments on the restoration of a disturbed coastal sage scrub habitat. Restoration Ecology, 1998. 6(1), 52-58.

Ahmad, R., &Jabeen, N. Demonstration of growth improvement in sunflower (Helianthus annuus L.) by the use of organic fertilizers under saline conditions. Pakistan Journal of Botany, 2009. 41(3), 1373-1384.

Muslat, M. M., & Saleh, S. A. Influence of date palm wastes fertilization on some growth and yield of cucumber parameters under protected cultivation. Anbar Journal of

Agricultural Sciences,2017. 15(1), 181-190.

Singh, N. ., & Gautam, P. . (2021). Comparative Analysis of Hypochlorite Method On Transgenic Strain By250. Journal of Advanced Zoology, 42(01), 01–06. Https://Doi.Org/10.17762/Jaz.V42i01.1

Al-Sahaf, F. H. Applied plant nutrition. University of Baghdad-Ministry of Higher Education and Scientific Research, 1989. 260.

Lal Choudhary, N. ., & Chishty, N. . (2021). Copulation Behaviors of Indian Vulture (Gyps Indicus) in Udaipur District, Rajasthan, India. Journal of Advanced Zoology, 42(01), 07–19. Https://Doi.Org/10.17762/Jaz.V42i01.3

Kapinder, Tarkeshwar, & Kumar Singh, A. . (2021). Influence Of Different Odours On The Associative Learning Of Larval Parasitoid Cotesia Plutellae (K.) (Hymentoptera: Braconidae). Journal of Advanced Zoology, 42(01), 20–33. Https://Doi.Org/10.17762/Jaz.V42i01.2

And Pulikeshi M. Biradar, M. F. N. S. R. P. . (2021). Growth and Reproduction Of The Epigeic Earthworm, Eisenia Fetida (Savigny, 1826) Cultured In Various Organic Wastes. Journal of Advanced Zoology, 42(01), 43–60. Https://Doi.Org/10.17762/Jaz.V42i01.5

Burezq, H. . (2021). Biochar In Cattle Farming: An Innovative Solution For Soil Fertility And Cattle Productivity. Journal of Advanced Zoology, 42(01), 61–96. Https://Doi.Org/10.17762/Jaz.V42i01.6

Wankhade, L. N. . (2022). Study on Butterfly Fauna of Karanja (Ghadge) Tahsil Of District Wardha (Maharashtra). Journal of Advanced Zoology, 42(02), 186–193. Https://Doi.Org/10.17762/Jaz.V42i02.53

Biswas, S. ., Bhagyasree, V. ., & Rathod, V. N. . (2022). A Checklist of Birds And Diversity of Avian Fauna in Mudasarlova Reservoir of Visakhapatnam, India. Journal of Advanced Zoology, 42(02), 165–175. Https://Doi.Org/10.17762/Jaz.V42i02.51

S.K. Tiwari, A. C. And. (2020). Binary Action of Chlorpyrifos-Methyl and Methoprene On The Larval Biochemistry Of Almond Moth, Ephestia Cautella Walker (Lepidoptera:Pyralidae). Journal of Advanced Zoology, 41(01-02), 117–131. Https://Doi.Org/10.17762/Jaz.V41i01.25

Harkrishan, And Anil K. Tyor, J. K. B. (2020). Sublethal Effects of Imidacloprid On Haematological and Biochemical Profile of Freshwater Fish, Cyprinus Carpio. Journal of Advanced Zoology, 41(01-02), 75–88. Retrieved From Http://Jazindia.Com/Index.Php/Jaz/Article/View/59