



# Impact of Some Organic Additives on Physical and Chemical Properties Soil and Lettuce (*Lactuca sativa* L.) Yield Quality

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## **Author's contribution**

*The sole author designed, analyzed, interpreted and prepared the manuscript.*

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## **ABSTRACT**

During 2019-2020 and 2020-2021 years, two-pot experiments were conducted in a clayey soil in Giza and a sandy one in Ismailia station of The Agricultural Research Center, Egypt .In these experiments, lettuce was fertilized using olive pomace ,vinasse and potassium humate (K-Humate) as partial potential substitutions for mineral fertilizers .Implications of these substitutes on growth lettuce growth parameters and its green yield as well as the physical and chemical characteristics of the soil under study .The experiments was laid out in randomized complete block design (RCBD) with nine treatments. Overall, the results of this study indicated that the application of venase 50>k-humates 50> k-humates 100 are as subsequence of these rates improved physical and chemical properties of the investigated soil. addition of 50% olive and vinasse recorded the best mean values of all tested parameters and improved growth, which reflected on yield parameter.

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**Keywords:** Olive pomace wastes; vinasse and k-humate; physical and chemical properties soil; lettuce *Lactuca sativa L.* yield.

## 1. INTRODUCTION

"Agriculture is a sector that produces about 23.7 million Mg of food per day over the world contributing to more than 21% of the greenhouse gases emissions [1]. The increase in agricultural production affects negatively soil, air and water resources Nowadays, the new global challenge is to reduce the environmental degradation by adopting more ambitious and rapid techniques to significantly improve the yield of economically important crops. Nonetheless, such highly productive systems proved to have some critical drawbacks related to sustainable fertility management. In the current eco-environmental context, the deterioration of soil fertility is one of most pressing issues facing agricultural productivity, and according to a report of the Global Environment Facility [2], the depletion of soil nutrient reserves is mainly attributed to soil organic matter deficiency. The Egyptian environment is often characterized by important annual losses of organic matter, due to high mineralization rates in the last decades, intensive applications of mineral fertilizers have substantially contributed to the pollution of ecosystems (atmosphere, soil and water) One of the possible options to reduce chemical fertilizers use may be the adoption of organic amendments, from recycling organic wastes. Moreover, sandy soils are coarse textured soils dominated by single grained structure, they have little shrinking or expansion properties due to the low clay content" [3]. "Application of organic amendments in sandy soils face the challenge of constant turnover, because of the decomposition rate is high and that the added organics are usually mineralized within only short cropping seasons" [4]. "The olive oil industry is an important economic sector in Mediterranean countries. However, olive is mainly used to produce oil, moreover, generates enormous quantity of wastes not only wood, branches, leaves but also by-products (olive pomace, olive mill wastewater, olive stones) with negative environmental impact and high costs for management and disposal" [5]. Podgornik et al. [6] stated that "the combined application of organic matter combined with a mineral fertilizer to olive grown on ethic camisoles positively affected the physical, chemical, and biochemical properties of the soil, due to the high organic matter content". "Concentrated vinasse can be regarded as industrial by-product containing

valuable active substances, recyclable to plant cultivation" [7]. "in the same pattern Vadivel et al. [8] concluded that vinasse application in agriculture has added a significant amount of nutrients, improved the soil quality of degraded land and increased crop yields". In this respect, Osman et al. [9] indicated that "the application of diluted vinasse (20%) with 25% from the potassium mineral fertilizer required to sandy soil has added a significant amount of nutrients, especially K and organic matter, which improved soil chemical properties, nutritional status and crop yield, meanwhile, Wafaa M.A. S. et al. [10] mentioned that available NPK in soil significantly increased with vinasse (4%). Humic acid is the most important fraction of soil organic carbon, and is important factor for maintenance of soil fertility as it is the main constituent of organic manures, through which it supplies nutrients, improves soil aggregation" [11], "The addition of poultry manure alone or combined with vinasses at different rates led to significant increases in the microbial biomass carbon (MBC), organic matter (OM), NPK soil availability and yield of barley" [12]. "Humic acids had a positive effect on plant growth, grain yield and quality, and photosynthetic metabolism of durum wheat crops [13]. Humic acid is one of the major components of the humic substances (HS). Tejada et al. [14] reported that the humic acids affect the plant growth both directly and indirectly, the indirect effect of humic acid improves physical, chemical and biological condition of soil, while the direct effects are attributed to its metabolic activity in plant growth". Ayman, M. M. A et al. [15] showed that "HA amended the soil structure by allowing rapid macro aggregate formation, decreasing bulk density and pH, and increasing porosity and electrical conductivity, thereby improving soil hydraulic properties".

The current work aims at studying the potentiality of partially substituting mineral fertilizers by some organic additives on growth and yield of lettuce grown on a clayey soil and a sandy one as well as their chemical and physical properties.

## 2. MATERIALS AND METHODS

### 2.1 Materials

**Soil:** Surface soil samples (0-30 cm) were collected from both Agricultural Research Center - Giza governorate and Ismailia agricultural

stations, the Agricultural Research Center to represent a fine textured soil and a coarse textured one, respectively. Physical and chemical properties of these soils are presented in Tables 1 and 2.

## 2.2 Organic Fertilizer

Potassium humate from the Agricultural Research Center (ARC) at Giza governorate – Egypt. Chemical composition of this compound is illustrated in Table 3.

## 2.3 Waste Originated Conditioner

Olive pomace from Olive Oil Production unit at the Horticultural Research Institute (ARC).

## 2.4 The Physical and Chemical Analyses

Samples of the soils under study were air dried, crushed, sieved to pass through a 2.0mm sieve and analyzed for their chemical and physical properties according to the standard methods outlined by Page et al. [16] and Klute [17] as follow: Electrical conductivity (EC) was determined in the soil paste extract by electrical conductivity meter soil electric conductivity (EC,  $dSm^{-1}$ )

Soil pH was measured in 1:2.5 soil: water suspension using a pH meter. The soil pH values were measured. Soluble carbonates and

bicarbonates were determined in a soil paste extract by titration against 0.01M sulphuric acid in presence of phenolphthalein and methyl orange indicators, respectively Calcium and magnesium were determined in a soil paste extract using the titration methods by versinate (0.01M) in presence of ammonium purpurate (murexide) and Eriochrome black T (EBT) indicators, respectively. Chloride concentration was determined in a soil paste extract using the silver nitrate (0.01M) in presence of potassium chromate as an indicator. Sulphate was calculated by subtracting total summation of total determined soluble anions from summation of total soluble cations. Sodium and potassium were determined in a soil paste extract by using flame photometer according to Page et al. [16]. The Organic matter was determined by the Walkely and Black, (1934) method. Cation Exchange Capacity (CEC) was determined using ammonium acetate (pH 7) and sodium acetate (pH 8.2) according to Page, et al. [16]. Exchangeable sodium was determined using ammonium acetate. Bulk density was determined soil samples according to Klute, [17]. Soil moisture characteristics curves were determined using the pressure cooker under 0.001, 0.10, 0.33, 0.66, 1.0, 3.0 and 15.0 atmosphere according to [18]. Hydraulic conductivity was conducted using falling head method according to [17].

**Table 1. Mean values of the physical and chemical properties of El Giza fine textured soil before planting**

Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)	Textural class	O.M mg kg <sup>-1</sup>	CaCO <sub>3</sub> mg kg <sup>-1</sup>	
7.45	20.85	30.44	41.26	Clay	7.5	29.0	
pH (1:2:5)	EC (dS/m)	Cations (mmolcL <sup>-1</sup> )				Anions (mmolcL <sup>-1</sup> )	
8.03	2.75	Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>
		10.90	5.66	10.07	0.87	5.65	12.33
Macronutrients (mg/kg)		Micronutrients (mg/kg)					
N	P	K	Fe	Mn	Zn	Cu	
38.55	5.20	178.00	3.40	2.33	0.65	0.40	

**Table 2. Mean values of the physical and chemical properties of El- Ismailia coarse textured soil before planting**

Coarse sand (%)	Fin sand (%)	Silt (%)	Clay (%)	Textural class	O.M mg kg <sup>-1</sup>	CaCO <sub>3</sub> mg kg <sup>-1</sup>	
12.80	73.20	8.30	5.70	Sand	6.2	18.5	
pH (1:2:5)	EC (dS/m)	Cations (mmolcL <sup>-1</sup> )				Anions (mmolcL <sup>-1</sup> )	
7.95	1.25	Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	Cl <sup>-</sup>
		3.85	2.90	4.87	0.88	1.54	3.22
Macronutrients (mg/kg)		Micronutrients (mg/kg)					
N	P	K	Fe	Mn	Zn	Cu	
33.50	3.96	185.30	1.49	0.89	0.55	0.38	

\*Impact of vinasse, olive pomace and K-humates on soil chemical and physical properties.

\* Chemical properties: Soil react (pH), EC, O.M%, CEC.

**Table 3. The chemical properties of the used K-humate**

Parameter	Value	Parameter	Value
pH	8.10	P mg L <sup>-1</sup>	9.6
OC %	0.63	Ca mg L <sup>-1</sup>	400
OM %	1.08	Mg mg L <sup>-1</sup>	336
C/N	1.21	Fe mg L <sup>-1</sup>	10.9
N %	0.52	Mn mg L <sup>-1</sup>	1.7
K %	4.00	Zn mg L <sup>-1</sup>	0.3
Na %	0.83	Cu mg L <sup>-1</sup>	0.5

**Table 4. The chemical properties of the used olive pomace were shown in Table as below :-**

Parameters	Value	Available nutrients	Value
Total COD (g <sup>1-</sup> )	131.87	N (%)	1.63
phenols (g <sup>1-</sup> )	6.95	P (%)	0.13
Total Carbohydrates (g <sup>1-</sup> )	24.57	K (%)	2.45
Oil and gease (g <sup>1-</sup> )	11.14	Fe (mg <sup>1-</sup> )	22.45
TSS	34.36	Mn (mg <sup>1-</sup> )	8.61
pH	4.53	Zn(mg <sup>1-</sup> )	10.14

**Table 5. The chemical properties of the used vinasse were shown in Table as below**

EC	pH	Density	Moisture	OM	TN	P%	K%	HMF	Total phenols	COD	BOD
(dS/m)		(ml/100ml)	%						(ppm)	mg /L	
1.035	4.4	54±3.1	60.3±0.29	4.5±0.00	3.05	5.44±0.65	6.4±0.15	12±0.40	0.41±0.005	48500	22500

The governing equation is:

$$K=(a\backslash At) \ln (H_1\backslash H_2)$$

Where:

- a= is the area of cross section of the stand pipe.
- l= is the length of the sample.
- A= is the cross sectional area of the sample
- t= is the time for the hydraulic head difference to decrease from H<sub>1</sub> to H<sub>2</sub>.

## 2.5 Pot experiment

The pots experiments were two-pot experiments clayey and a sandy have been cultivated in pots with size capacity of 10 kg soil (1 transplant /10 kg pot) lettuce was fertilized using olive pomace, vinasse and potassium humate (KH) all treatment as well as **Table 6**. Partial potential substitutions for mineral fertilizers. Implications of these substitutes on growth lettuce growth parameters and its green yield. The design of the current pot experiment was randomized complete block design. The capacity of each pot used in this experiment was 10 kg soil. Each soil pot was thoroughly mixed with either of the investigated organic amendments as shown in Table 6. Soils under study were fertilized with NPK rate of 45:150, 45:65 kg /ha as N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O as mentioned by El-Mogy, et al. (2020). The mineral NPK fertilizers used in this study were ammonium nitrate (33%N), calcium super phosphate (15.5% P<sub>2</sub>O<sub>5</sub>) and Potassium sulfate K<sub>2</sub>SO<sub>4</sub> (48% K<sub>2</sub>O) as Egypt ministry of agricultural recommended. Calcium super phosphate was added once to soil in each pot

before transplantation of the lettuce plant seedlings. Each of the ammonium nitrate and potassium sulfate was added at two doses, the first one (half the dose) 15 days while the second one 30 days after transplantation. Lettuce seedlings (*Lactuca sativa L.*) of 40 days old were brought from Horticulture Research Institute at ARC- Giza governorate. Lettuce seedlings (almost uniform in size) were transplanted during the second week of September in the two growing seasons, 2020/2021 and 2021/2022 into the aforementioned pots at a rate of one seedling/ pot.

The other agricultural practices were done according to the recommended methods for lettuce crop [19]. After harvest, both lettuce and soil samples were collected for determination of yield parameters, chemical and biochemical properties.

## 2.6 Chemical Analyses of the Olive Pomsace, Vinasse and Potassium Khumates

Electrical conductivity (EC) and pH were determined using a Jenway 4310 EC meter and Beckman pH meter. Total phenols were estimated spectrophotometric ally according to Swain and Hillis, [20]. HMF was determined as mentioned by Zappala, et al. [21]. Total nitrogen, K<sub>2</sub>O and P<sub>2</sub>O<sub>5</sub> were determined as described by A.O.A.C. [22].

The following data were recorded for the experimental soil after 30-day from the last application of treatments.

**Table 6. The layout of the experimental design**

Soil	Treatment.	%
The Fine textured soil	Control	0
	Olive pomace	100%
		50%
	vinasse	100%
		50%
	K- Humate	100%
Sandy The coarse textured soil	Control	0
	Olive pomace	100%
		50%
	vinasse	100%
		50%
	Humate-K	100%
		50%

“Electrical conductivity and pH were determined using a Jenway 4310 EC meter and Beckman pH meter. Potassium (K) and phosphorus (P) contents were estimated using Atomic Absorption Spectrophotometer” according to Cottenie, et al. [23]. Total nitrogen (T.N) was determined by the Kjeldahl method [23]. Organic carbon was calculated according to [16], Soil biological activities Quantitative determination of enzymatic.

## **2.7 Chemical Characteristics of Vegetative Growth**

Macro-elements: “Nitrogen (%) was estimated according to [24] using the modified micro Kjeldahl method”. According to [25], “phosphorus (%) was calorimetrically measured”. “Potassium (%) was determined according to [26] using Flame photometry instrument”.

### **2.7.1 Vegetative growth**

At the end of growing seasons, the selected shoots were measured to determine the average number of leaves and average fresh weight of shoot. Five lettuces were collected randomly for this measured. “The percentage of total soluble solids (TSS) in each fruit juice sample was determined using a hand refractometer”, [22].

## **2.9 Statistical Analysis Procedure**

“All experiments and analytical determinations were replicated at least three times and the presented data are the mean values. The obtained results were subjected to one way (ANOVA) analysis of variance analysis (type of analysis depended on the factors affected the experiment) to determine the significance between treatments using CoStat software” [28].

## **3. RESULTS AND DISCUSSION**

### **3.1 Effect of Vinasse, Olive Pomace, and Potassium Humate, Additive in Both Loam and Sand Soil on Macronutrient Concentration in Lettuce Leaves**

Significant treatment influences were recorded for leaf N, P and K Contents (Fig. 1). All soil treatments caused significant increase in leaf nutrient concentrations during both studied seasons. Soil applications with k-humate and vinasse resulted in significantly higher leaf N, P and K concentration (Fig. 1), with nonconsiderable leaf N concentrations in response to olive pomace applications. In both seasons, leaf P concentration was highest in

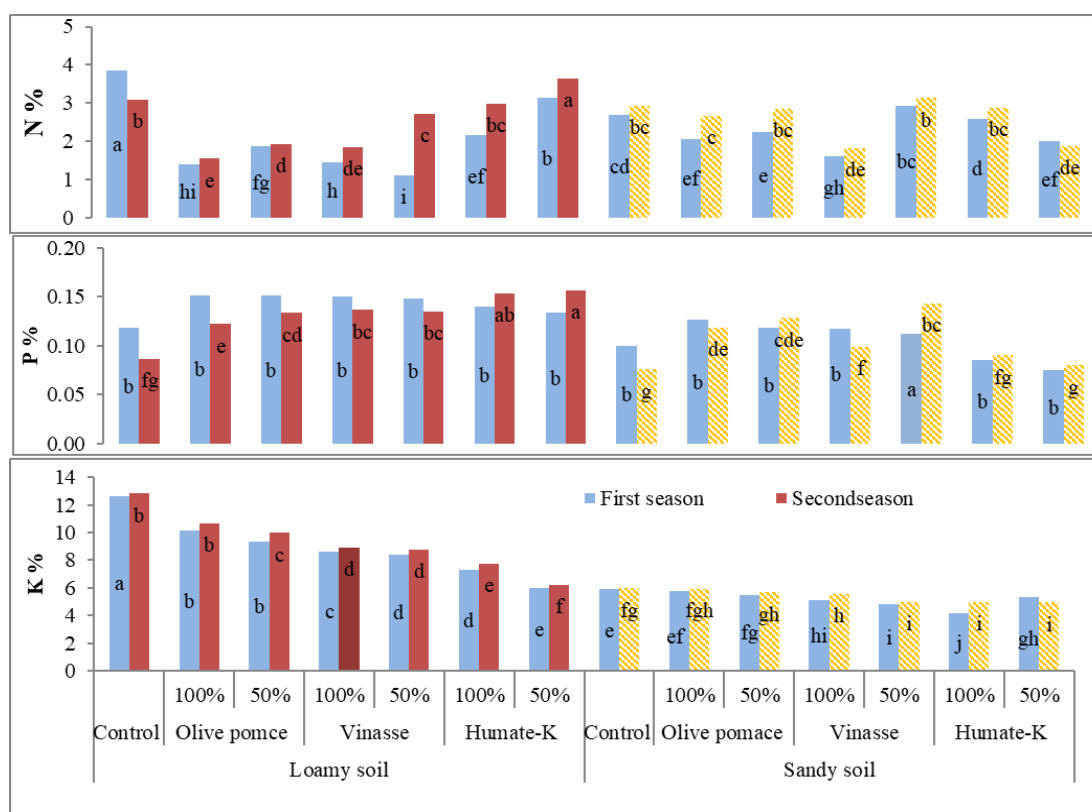
response to all treatment of soil. specially in loam soil while in sand soil lowest ratio in k-humate was observed.

“In both seasons all treatment whether in loam and sand soil resulting in significantly higher leaf K concentrations than the control. Fig. 1. Previous studies have reported that leaf nutrient concentrations were increased with a ground agro-industrial waste application in several crops this enhancement can be due to the availability of nutrients in root-zone; and moreover, gradual increase of leaf nutrients is also due to the plant growth” Carvalho et al. [28], Mansour [29] data obvious that nitrogen decrease in treatment by vinasse and olive leaf than control it may be due to N consumed in formation head of lettuce [30]. “on the other hand, humic substance application has been resulted in decreased pH on the root surface, thus facilitating the uptake of  $H^+$ / $NO_3$  symports, availability of  $NH_4^+$  and enhance N organic compounds in plants, While, vinasse application increased plant nutrients concentration” Schiavon et al. [31]. “but it is also affected by nutritional and environmental factors Application of vinasse and olive pomace before lettuce planting provides nitrogen and other nutrition elements This can be due to application of byproduct along with chemical fertilizers that caused providing higher potassium and phosphorus” [32,33].

## **3.2 Physiological Parameters**

### **3.2.1 Fresh weight, head diameter and leave number**

Marketable quality of lettuce is determined mainly by plant size, which depends on fresh weight. Significant difference of fresh weight at transplanting time are differed among four treatments. At the time of transplantation of lettuce plant, it was noticed that lettuce gave Variance analysis showed that sources of agroindustrial waste had significant effects on lettuce yield (Fig. 2). In loam soil Means comparison showed that the treatment of olivepomace50% caused a significant increase in fresh weight yield, while K-Humate50% and vinasse50% there is inconsiderable difference (177, 159, 159% respectively) in season one and recorded (168, 153, 154%). likewise, in sand soil compared to other treatments in two seasons respectively (176, 167, 168, 174, 158, 167%). Several factors can increase lettuce yield in waste additive. Uptake of nutrients such as N and K in the application of vinasse and olive is one of the factors increasing the lettuce yield that was demonstrated in this study.



**Fig. 1. Effect of vinasse, olive pomace, and potassium humate, additive in both loam and sand soil on macronutrient concentration in lettuce leaves**

Various soil applications under green house had significant impact on lettuce yield (Fig. 2) applied ameliorated the growth of lettuce plants by significantly increasing all examined growth parameters (i.e., fresh weight, head diameter, leaf number and total soluble solid%) compared to their controls (Fig. 2). These might be due to improve physical and chemical properties of olive and vinasse additive that were discussed earlier Tables 7,8,9,10. Rahman et al. [34] reported that fresh weight of lettuce increased with increasing the volume of nutrient applied. Michael and Lieth [35] reported that an increased in total pore space will often decrease the water retention, increase oxygen transport and increase root penetration. These, in turn, will influence plant growth. Thus, the fresh weight in 100% of olive and vinasse waste based growing media reduced drastically in the present experiment. On the other hand, Meanwhile, pH and EC with other properties were more appropriate in 50% olive pomace and vinasse based growing media resulting higher fresh weight of lettuce. It can improve the total marketable fresh weight of lettuce. Andriolo et al. [36] also stated that EC levels above 2.0 and 2.6 dS m<sup>-1</sup> reduced fresh yield and plant growth, respectively in lettuce.

Soil application of vinasse and olive pomace with different concentration Increased significantly growth and yield of lettuce.so they could play a fundamental role in the maintenance of the rhizosphere ecosystem. Also, for organic farming systems application to soils of these wastes represents an interesting option, closing the cycle of residues-resources [37]. Additive applications of K- humate was more effective than vinasse. Also 50% vinasse seem to have the best effect on growth and yield compared other treatments.

Additive waste and humate efficacy on lettuce effect on pH, EC and organic matter content of soil When added to both soils, all treatments influenced the soil pH, EC and OC properties compared to control, even if the effects were different and depended on the type of byproduct used and also on the starting organic wastes from which the byproducts came from. Regardless of the type of initial material of waste (Fig. 1) 50% vinasse and 50% olive Influenced more soil characteristics, enhancing significantly and concomitantly the amount of OC, field capacity and hydrolytic soil activities as well as PH and EC (Tables 7, Fig. 3).

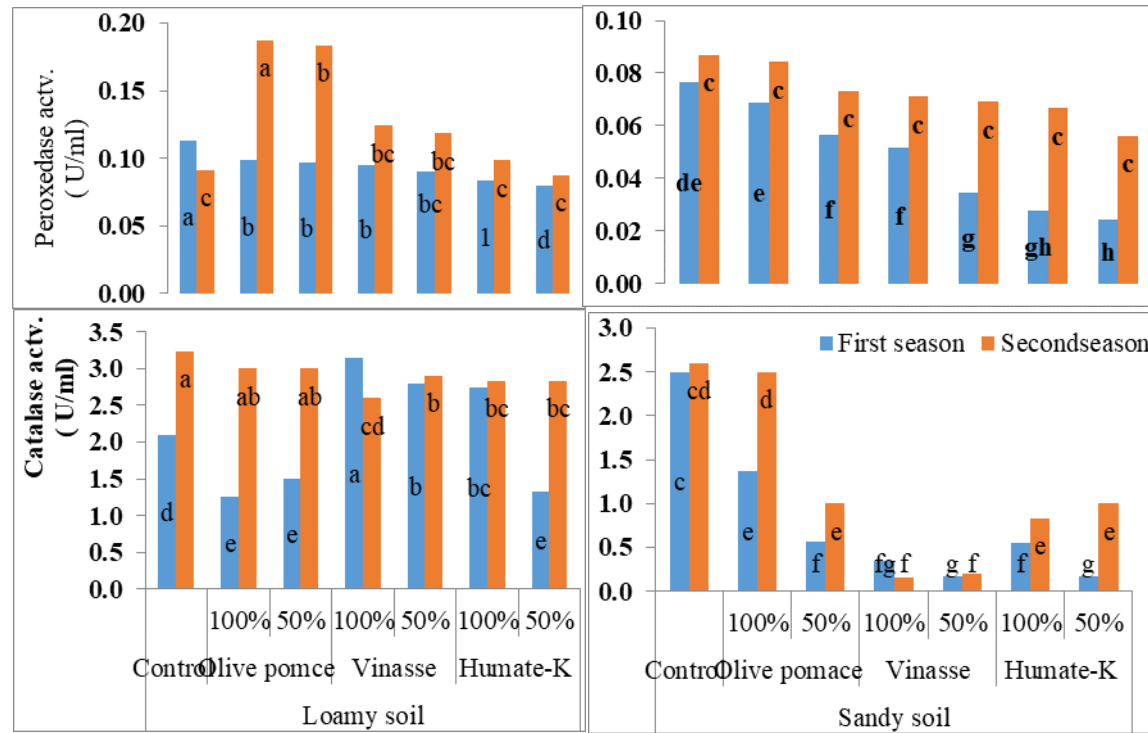


Fig. 2. Effect of ground additive vinasse, olive pomace and k-humate in loam and sand soil on catalase and peroxidase activity for lettuce plant



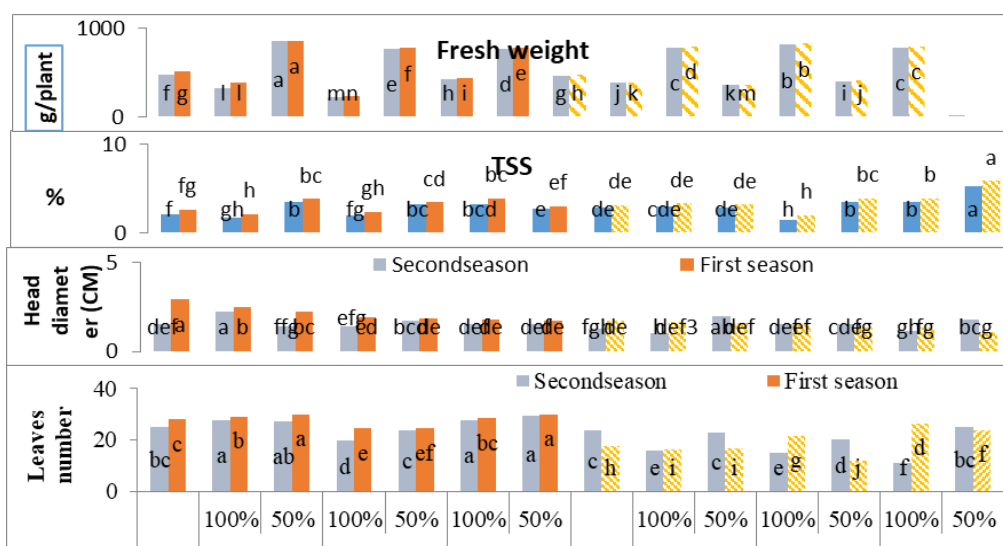


Fig. 3. Effects of additive waste on fresh weight, TSS%, head diameter and number of leaves of lettuce at harvesting time

Table 7. Characteristics with each treatment waste (olive pomace, vinasse) and K-humate understudy

Characters	pH	EC (ds/m)	Hydroxyl methyl forforal (mg/g sample)	Total phenols (ppm)	N %	P	K	Organic Matter
Treatments				mg phenol/100g				
Olive pomace	5.9	2.1	62.8908	172.1665	1.29	0.28	0.7	15.4
Vinasse	4.3	12	205.1438	472.1501	0.23	0.35	5.46	6.2
Humate-k	15.5	74.6	145.3975	0.1	4.3	1.7	4.4	1.08

There is a considerable discrepancy in the treatments as a result of additive different concentrations of residues and the most affected of them PH and OC specially in loam soil. while in sand soil there is slightly significant during two seasons Fig. 3. PH was significantly lower in loam soil treated with both vinasse and k-humate 50% than the other treatments, conversely in sand soil there was slightly increase in ph. while OC considerably enhanced in all the treatments and the highest amount was in soil treated with both vinasse and olive (Fig. 3) during two seasons. A clear increase in EC was observed for vinasse treatments whether loam or sand soil under the same condition. The results evidenced that the type of byproducts, regardless of the type of waste, (Table 7). In short, both the two types of wastes examined seemed to produce byproducts with promising fertilizing capabilities. The ranking of treatments to ameliorate soil fertility were as follow: olive 50% and vinasse 50% compare with K-humate as fertilizer improves soil properties This was evident in the

soil mechanical measurements Tables (9,10,11,12,14). These results evidenced specificity between treatment and soil properties, pointing out as the effects of different concentration of byproduct depended on its own chemical characteristics. The results, evidencing the positive effects of two byproducts, agreed with previous works highlighting as organic components were able to improve soil fertility [38], Chang et al, [39] and Tittarelli et al. [40]. The efficient transformation of these wastes into useful byproducts, is in line with the Optimum guidance for waste recycling and its exploitation in sustainable agriculture. In soils treated with different concentration of wastes the increase of key soil properties due to byproduct addition can be related to the composition of vinasse and olive pomace itself. Olive pomace contained more organic matter compared to the other byproduct, while vinasse has more nutrient. Additionally, when an additive matter is added to soil, there was a significant effect on PH, EC and OC specially in loam soil.

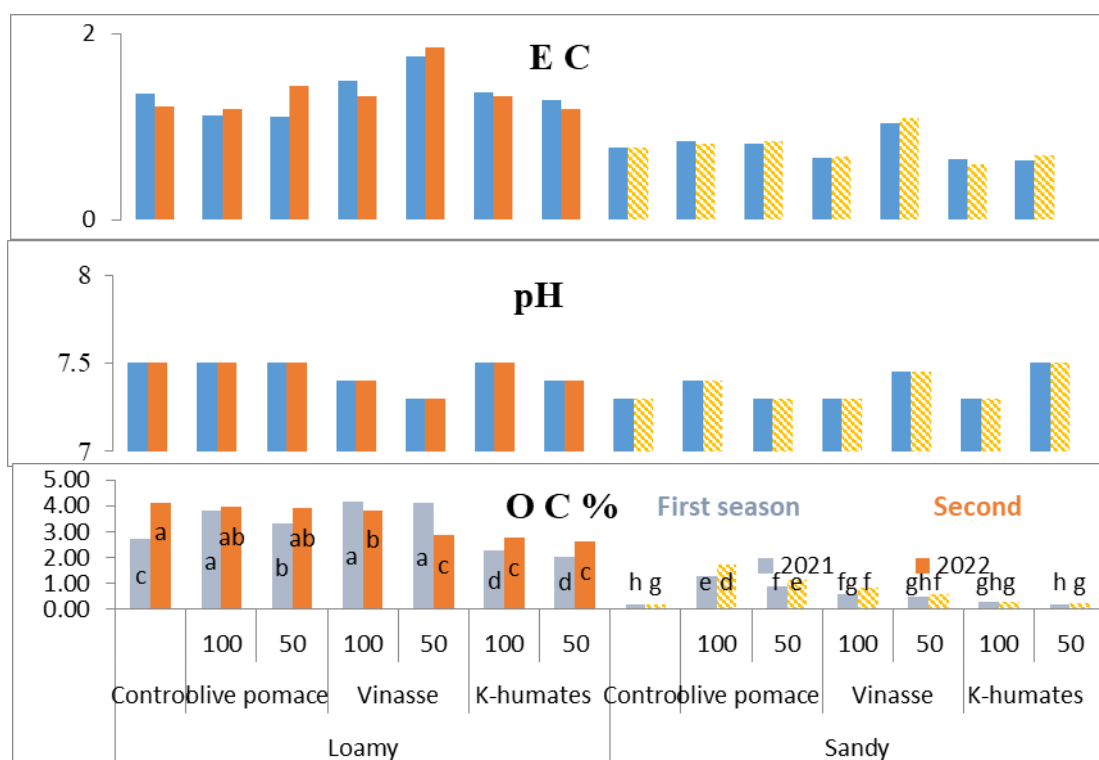


Fig. 4. Changes in loam and sand soil properties after olive pomace, vinasse and k- humate application

### 3.3 Chemical and Physical Properties in Soils Studied

A knowledge of the amount of water held by the soil at the various tensions is required if we are to calculate the amount of water that is available to plants, the amount of water that can be taken up by the soil before percolation starts, the amount of water that should be used for irrigation, and many other items of hydrologic importance. As per the FAO report. (2009), it is projected that the world's population will increase by 2.3 billion people by 2050, and most of this growth would be witnessed in developing countries. In a projection stated by World Population prospects of United Nations, 2019, feeding the ever-growing world population of 9.7 billion in 2050 would require increasing the food production by almost 70% by the year 2050.

EC, Data presented in **Table 8** showed that, all treatments are not significantly different from one another. But vinasse50% treatment is a higher value of Ece which is compare with control and all treatment, on anther hand, results found degree in a higher K-humates, Vinasse but its comedown in olive pomace100, so that, this due to the high concentration of monovalent cations, particularly sodium. Paz et al. [41]. Wafaa et al.

[42] reported that, EC values in soil at both studied seasons increased due to the application of vinasse. This is possibly due to relatively high concentration of dissolved salts in the vinasse. On another hand Sandy soil, results showed that all treatments are not significantly different from one another. but, results showed that, vinasse50% treatment is a higher value of Ece which is compare with control and all treatment, results found two treatments of K-humates 100% and 50% is lowest EC value in as compare all treatment and control this due to, but pH, results in Table 7. showed that in Loamy soil, there are no significant pairwise difference among the means all treatments are not significantly different from one another. "but results revealed that pH values generally decreased due to application of vinasse100at second studied season, which as compare with all treatments This is possibly due to organic matter oxidation (H<sup>+</sup> act as electron acceptor) and high content of free hydrogen ions" [43]. Wafaa. S. et al, [10], studied that, "pH values generally decreased due to application of vinasse and feldspar mineral at both studied seasons. Values decreased gradually by increasing the rates of vinasse or feldspar from 75 % to 100 %. Treatment of vinasse (75%) combined with feldspar (25%) was superior in decreasing pH values at both studied

Table 8. Some Chemical properties of the studied soils lettuce (*Lactuca sativa L.*)

Soil type	Treatment		EC ( $\mu\text{s/cm}$ )		pH		O.M%		CEC		
	Season	%	First	Second	First	Second	First	Second	First	Second	
Loamy	Control		1.35ab	1.22 ab	7.5 a	7.4 ab	2.7c	4.13 a	13.41 b	13.38c	
	olive pomace	100	1.12 ab	1.19 ab	7.5a	7.3b	3.83a	3.95 ab	13.4b	13.38 c	
		50	1.11 ab	1.43 ab	7.5 a	7.5 a	3.33b	3.90 ab	13.39 c	13.4b	
	Vinasse	100	1.49 ab	1.32 ab	7.4 ab	7.2c	4.15 a	3.83b	13.38 c	13.39 c	
		50	1.76a	1.85 a	7.3 b	7.5 a	4.10 a	2.87c	13.41b	13.38c	
	K-humates	100	1.37 b	1.32 b	7.5 a	7.3 b	2.3 d	2.76 c	13.4 b	13.41 b	
		50	1.28 b	1.19 b	7.4 ab	7.5 a	2.04 d	2.6 c	13.39c	13.38 c	
	LSD <sub>0.05</sub>		0.5	0.49	0.14	0.14	2.3	2.35	0.22	0.22	
	Sandy	Control		0.78abc	0.77 abc	7.3 b	7.4 ab	0.18 h	0.2g	13.68 a	13.65 a
		olive pomace	100	0.84 ab	0.81 ab	7.4 ab	7.4 ab	1.30e	1.73d	13.656 a	13.645 a
50			0.82 ab	0.85 ab	7.3 b	7.3 b	0.87f	1.13e	13.68 a	13.67 a	
Vinasse		100	0.66c	0.68 c	7.3 b	7.5 a	0.6 fg	0.83f	13.67 a	13.65 a	
		50	1.04 a	1.09 a	7.45 ab	7.3 b	0.5 gh	0.6 f	13.656b	13.645 a	
K-humates		100	0.65 c	0.6 cd	7.3 b	7.4 ab	0.28	0.31g	13.68 a	13.67 a	
		50	0.64 c	0.69 c	7.5 a	7.5 a	0.22h	0.24g	13.67 a	13.66 a	
LSD <sub>0.05</sub>			0.5	0.49	0.14	0.14	2.3	2.35	0.22	0.22	

seasons due to the acidic effect of vinasse". On another hand Sandy soil, results showed that all treatments are not significantly different from one another. but, results revealed that pH values generally decreased due to application of olive pomace waste 50% at two season studied, while vinasse100in first season studied and vinasse50% in second studied season. On another hand, the treatment K-humates 100% at first studied season. This is possibly also due to organic matter oxidation. Wafaa M. T. E et al. [10]. showed that, "no significant response of mean pH values to nitrogen rates of 100, 75 or 50% of N compared to control treatments. Generally, the same results were observed among other treatments at the two studied seasons". "This may be due to that potassium humate works as a buffer which help to stabilize soil against strong pH changes created from fertilizer application. This agrees with resultant of" Campitelli et al. [44].

"Long-term application of vinasse whether to cause soil acidification in sugarcane fields, is the problem that people are most concerned about, and also is the key whether vinasse application can be practical in commercial production". Ze-P u Jiang et al. [45]. Leïla Chaari et al [46], "The results showed that the pH of the different soil layers varied from 7.4 to 8.3. During the OMW treatment process, the soil pH at surface horizons (0–20 cm), particularly those of the soil samples treated with 200 m<sup>3</sup> ha<sup>-1</sup>, were noted to increase in comparison to the control. The pH increase did not exceed 0.5 units for the soil treated with 200 m<sup>3</sup> ha<sup>-1</sup> in relation to the control soil". Mekki et al. [47] reported that "pH does not vary according to the depth". Magdich et al. [48] reported that "the soil pH at surface horizons treated with olive pomace, were noted to decrease in comparison to the control, which could presumably be attributed to the acidic nature of olive pomace. Also, electrical conductivity (EC) was significantly affected by the application of olive pomace, showing increases after spreading in the treated soils compared with the controls. Nevertheless, EC values remained below the salinity threshold (4000 μS cm<sup>-1</sup>), except for soil samples treated with 100 and 200 m<sup>3</sup> ha<sup>-1</sup> in the upper layer". These results were consistent with previous works, reporting EC increases during the irrigation times [49,50], (DE. Moraetis et al.2011), Di Bene et al. [51], Leïla Chaari et al. [46]. Soha R.A. Khalil et al. [52]. The results Showed that the addition of vinasse and potassium Sulphate led to a slight decrease in pH, which may be due

to the acidic nature of vinasse, as well as a slight increase in salinity (EC) of sandy soil as compared to the soil pH and EC before their application. O.M%, and results found that, two treatment vinasse 50-100 O.M% increase in first season as compare second season while treatment of olive pomace100 is higher as compare Control this due to organic matter content increased with the application of vinasse (V1and V2) as compared to control. indicated that organic matter content increased with the application of vinasse (V1and V2) as compared to control. (Wafaa M.A. S. et al. [10]. reported that, so that, this may be due to vinasse relatively high content of organic matter [53]. Furthermore, results showed that the highest values of organic matter content (OM) exist in case of vinasse (V2) and vinasse combined with feldspar (75% V+ 25% F) at both studied seasons. These results are in agreement with Arafat and Abd-Elazim. [54] who found that organic matter in soil after harvesting increased with increasing the rate of vinasse applied. Of course, this may be due to vinasse relatively high content of organic matter Table 8. [53]. Moreover, results showed that the highest values of organic matter content (OM) exist in case of vinasse (V2) and vinasse combined with feldspar (75% V+ 25% F) at both studied seasons. These results are in agreement with Arafat and Abd-Elazim. [54] who found that organic matter in soil after harvesting increased with increasing the rate of vinasse applied. Another hand, the lowest values exist in case of different K-humates rates.in sandy soil all treatments are not significantly different from one another.

Leïla Chaari et al. [46], reported that, "as a consequence of irrigation with vinasse, the OM content in the topsoil increased from 0.18% in the control to 0.4, 0.7 and 0.8 % after 50, 100 and 200 m<sup>3</sup> ha<sup>-1</sup> of OMW application, so that, the soil surface horizons (0–20 cm) were noted to exhibit the highest levels of soil organic matter content. The most important difference was particularly observed between the 200 m<sup>3</sup> ha<sup>-1</sup> treated soil and non-treated soil. Furthermore, for the treatment using the highest amount of OMW, the organic matter content recorded in the surface horizon reached 4 folds (0.76%) as compared to the control (0.18%). CEC, results showed all treatments are not significantly different from one another". Wafaa. E et al. [10], results showed that, "a significant positive response for CEC with effectiveness all treatments compared to control treatments. so, there were significant responses of nitrogen rates

Table 9. Soil moisture contents (%) in two type soils as affected by the soil amendments and plants grown thereon

Soil type	Treatment	%	Soil tension (Bar)								
			0.001		0.1		0.33		15		
	Season		First	Second	First	Second	First	Second	First	Second	
Loamy	Control		97.17fg	94.78 d	87.17 e	87.17g	82.171 fg	82.17 fg	70 fg h	67.5 e	
	olive pomace	100	92.40688 g	92.40688 d	87.4068 e	87.4068g	82.40688 fg	82.406 fg	65 h i j	62.5 g	
		50	92.40688g	93.99497 d	82.4068 ef	82.406e	72.40688 h	72.406 h	60 jk	65 f	
	Vinasse	100	121.6997b	107.0532 c	116.699 b	105.93b	101.6997 b	101.69b	85 a	72.5 d	
		50	112.171bcd	116.935 b	95.17f	95.171 f	87.1711 de	87.17 de	70 f g h	77.5 a	
	K-humates	100	106.699 de	109.435 c	101.7cd	101.69 cd	91.6996cd	91.699cd	80 b c	75 ab	
		50	137.406a	122.053 a	132.406 a	117.05a	117.406a	104.55ab	65 hij	72.5 d	
		LSD <sub>0.05</sub>		2.379	1.6082	2.4486	2.052	1.7282	1.3806	1.1612	1.6809
	Sandy	Control		97.6426 e	96.97e	77.64 e	<b>75.14 e</b>	72.6426 ef	73.08 gh	60 hi	62 h
		olive pomace	100	106.935a	106.37 a	101.935a	101.35a	86.9354b	86.26bc	75 cde	76 abcd
50			102.292cd	102.44 cd	89.7907ef	89.91cd	79.7938cde	79.903h	67.48 fg	69 fg	
vinasse		100	104.699abcd	103.011 bcd	91.6996def	89.011cd	81.69bcd	82.011bcdef	75 cde	76 abcd	
		50	102.897 cd	102.59 cd	87.025f	85.83d	77.5332 de	77.34fg	67.5 fg	69 fg	
K-humates		100	106.086 ab	104.036 abc	102.055a	101.54a	98.0867 a	95.063 a	85 a	80 a	
		50	101.322d	101.65 d	97.8def	97.704ab	82.3224bcd	86.7 bc	78 bc	79.5 ab	
		LSD <sub>0.05</sub>		1.426	1.3366	1.1344	1.2005	1.0668	1.9503	2.1328	1.8538

\* Total porosity T.P% is point 0.001 soil tension (Bar)

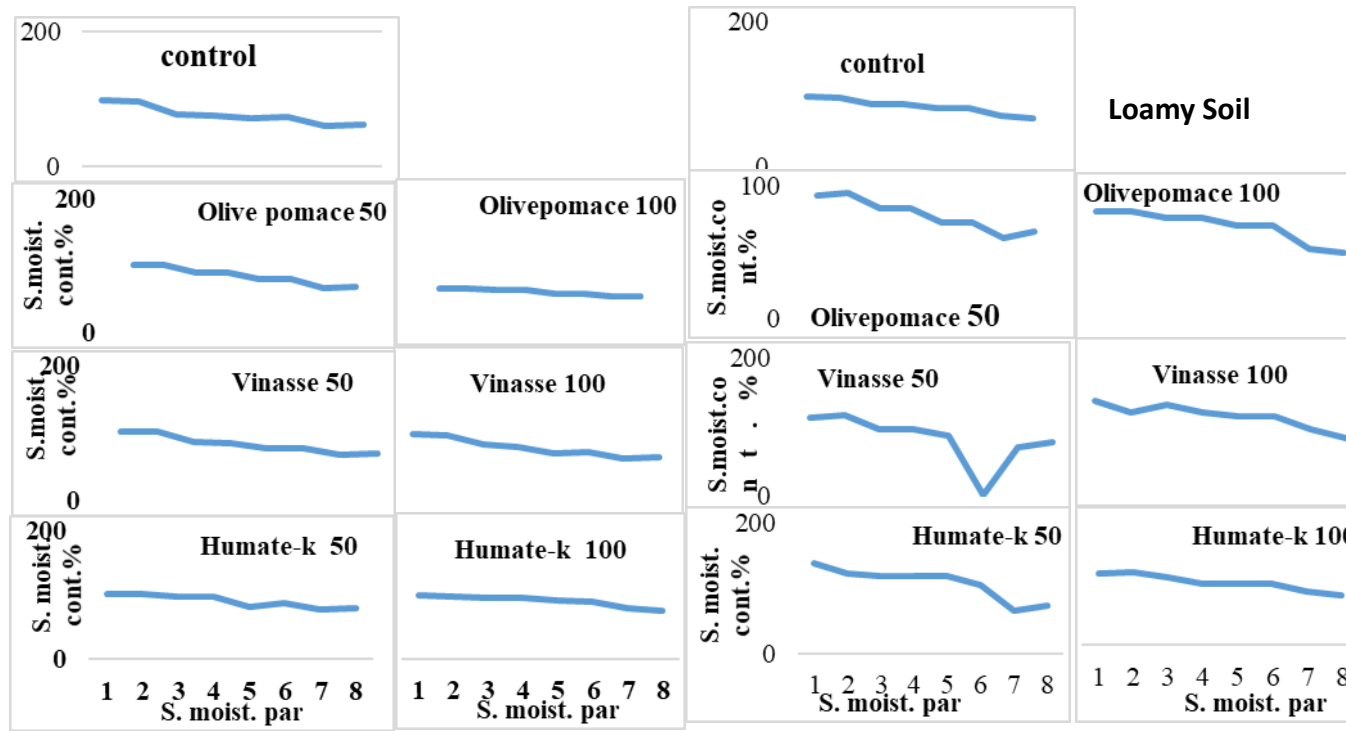


Fig. 5. Soil moisture contents (%) in two type soils as affected by the soil amendments and plants grown thereon

**Table 10. Pore size distribution of the studied soils lettuce (*Lactuca sativa* L.)**

Soil type	Treatment	QDP		SDP		WHP		FCP			
		Season	%	First	Second	First	Second	First	Second	First	Second
Loamy	Control			10 bc	7.618defg	5 d	4.76427 hi	12.17c	14.90688 bcde	70 fgh	67.5 e
	Olive pomace	100		5 d	5 e fgh	5 d	5 hi	17.4 b	19.90688 b	65 hij	62.5 g
		50		10 bc	11.58809 cde	10 b	10 bc	12.4c	7.40688 ef	60 jk	65 f
	Vinasse	100		5 d	1.1178 gh	15 a	4.2357 ij	16.69 b	29.1997 a	85 a	72.5 d
		50		17 a	21.76425 a	8 bc	8 de	17.17 b	9.67115 def	70 fgh	77.5 a
	K-humates	100		5 d	7.7353 de f g	10 b	10 bc	11.69c	16.6997 b	80 bc	75 ab
		50		5 d	5.0002 e f g h	15 a	12.50007 b	52.4 a	32.0532 a	65 hij	72.5 d
LSD <sub>0.05</sub>			1.5413	1.8626	1.4866	1.3728	3.3467	2.3277	1.1612	1.6809	
Sandy	Control			20 a	21.83 ab	5 ef	2.06 g	12.64 ab	11.08b	60 hi	62 h
	Olive pomace	100		5 f	5.2 ef	15 a	15.09 a	11.93 bc	10.26	75 cde	76 abcd
		50		12.5 cd	12.53 c	10 cd	10 bc	12.31	10.90b	67.48 fg	69 fg
	Vinasse	100		13 cd	14 c	10 cd	7 def	6.69 f	6.011	75 cde	76 abcd
		50		15.67 bc	16.67 bc	9.49 cd	8.49 cdef	10.03 d	8.34c	67.5 fg	69 fg
	K-humates	100		4.031 f	2.49 ef	3.69 f	6.47 ef	13.086 a	15.063 a	85 a	80 a
		50		3.97 f	3.95 ef	15.48 a	15 a	4.32 g	3.7 g	78 bc	79.5 ab
LSD <sub>0.05</sub>			1.8117	1.9651	1.5287	1.5609	1.3926	1.4322	2.1328	1.8538	

QDP: Quickly drainable pores (> 28.8 u), SDP: Slowly drainable pores (28.8-8.62 u), WHP: Water holding pores (8.62 - 0.19 u), FCP: Fine capillary pores (<0.19 u).

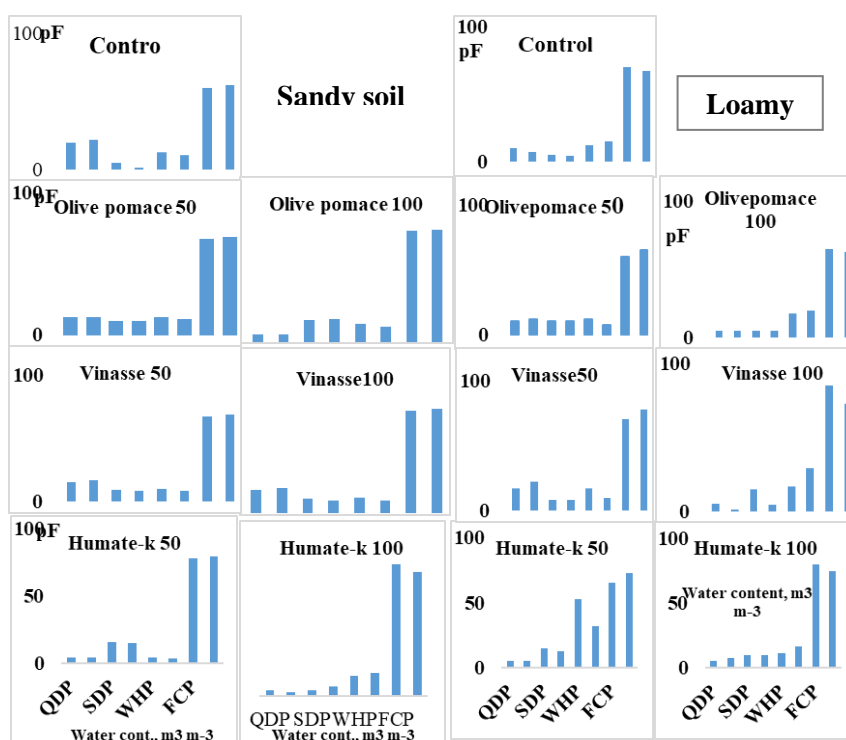


Fig. 6. Pore size distribution of the studied soils lettuce (*Lactuca sativa L.*)

fertilizer 100 or 75 as well as 50 % of N. The superior treatment was obtained at bentonite + potassium K-humates which being shown the effect favorable of organic and mineral soil conditioner on chemical and physical soil properties. Due to the K-humates which is rich in carboxylic, phenolic groups, and aromatic nature provide favorable soil conditioners it has been biological activity; chemical reactions and physical improvement of soil its promoting chemical reaction for cation exchange capacity” [55,56]. Also, Croker et al. [57] decided that “bentonite was considered a 2:1 clay mineral which increases in the CEC simply as a consequence of a high net permanent negative charged in soil. Moreover, that, it can also improve the retention and availability to sandy soil”.

### 3.4.1 \*\* Physical properties: -

Data presented in Table 10 showed that, The results presented in Tables 9, 10 showed that in Loamy soil , QDP point ,there are not significant from one another but the treatment of vinasse 50 was best from another all treatment in first year as compared to control, on anther hand second year all treatment are not significant from one another, SDP point ,the results found that the two treatment venass100and K-humates 100 is

significant as comparative with control and all treatment and wetting holding point WHP the results indicate that treatment of K-humates 100 is best significant in two season after that the treatment of vinasse 100 in season two. on other hand, as results revealed that in Sandy soil, QDP point, there are not significant from one another as compared to control, SDP point, the results showed that, the two treatment venass50 is the best and its significant as compare with control and all treatment. WHP the results indicated that treatment of K-humates 50 is best significant in two season, also results revealed that the values of FC, WP and AW increased gradually by increasing the rate of K-humates 100 it’s the best treatment as compare with control and all treatment. These results are in harmony with Wafaa. S. [10], reported that “using of different vinasse rates to the soil increased field capacity (FC), wilting point (WP) and available water (AW) as compared to control at both growing seasons. Also results revealed that the values of FC, WP and AW increased gradually by increasing the rate of vinasse”. “The high rate of vinasse (V2) was more effective on increasing the values of the studied properties, as compared to the low rate of vinasse (V1). due to its relative high content of organic matter that necessary for forming stable aggregates and increased soil structural stability” [58]. Jiang et al. [43] found



that “application of vinasse at the rate of 75 t/ha increased the macro aggregates over farmer practices and had more of larger size aggregates (>1 mm) with high amount of biodegradable carbon and nitrogen that has more significance to soil fertility. On the other hand, the most inferior treatment for soil moisture content was recorded for no vinasse application (control treatment). This inferiority could be due to absence of organic matter of vinasse”. Laime et al. [59] found that “disposal of sugarcane vinasse to soil had beneficial effects on crops and some physicochemical characteristics, such as an increase in moisture retention, porosity”. Ze-Pu Jiang et al. [45] Reported that, “after 2–3 years of continuous vinasse application to sugarcane fields, the soil bulk density declined, while the total porosity and capillary porosity increased in the plow layer of soil. The soil water stable aggregate content enhanced, but the soil clay content decreased. Soil K content increased, and soil did not show the phenomenon of acidification. The vinasse application in sugarcane fields resulted in improved physicochemical properties of soil, and soil hardening and soil acidification were not detected in the field”.

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water (AW) as compared to control at both growing seasons. Also results revealed that the values of FC, WP and AW increased gradually by increasing the rate of vinasse”. “The high rate of vinasse (V2) was more effective on increasing the values of the studied properties, as compared to the low rate of vinasse (V1). due to its relative high content of organic matter that necessary for forming stable aggregates and increased soil structural stability” [58]. Jiang et al. [43] found that “application of vinasse at the rate of 75 t/ha increased the macro aggregates over farmer practices and had more of larger size aggregates (>1 mm) with high amount of biodegradable carbon and nitrogen that has more significance to soil fertility. On the other hand, the most inferior treatment for soil moisture content was recorded for no vinasse application (control treatment). This inferiority could be due to absence of organic matter of vinasse”. Laime et al. [59] found that “disposal of sugarcane vinasse to soil had beneficial effects on crops and some physicochemical characteristics, such as an increase in moisture retention, porosity”. Ze-Pu Jiang et al. [43].

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The results indicated that all treatment gave nonsignificant results with each of the olive pomace 50, olive pomace 100additives compared to other additives such as Vinasse and K-humates. Previous studies confirmed that, effect in many of the measured soil parameters compared with control due to the OMW application. The soil measured chemical parameter concentration increased with the increase in olive pomace application rate and the effect of direct spreading on soil chemical features. All soluble and insoluble olive pomace compounds are involved in several physico-chemical and microbiological transformations, which influence their mobility and biodegradation. Just after spreading, the olive pomace chemically and physico-chemically modifies the soil. In addition, the microbial activity determines the on

soil chemical and physical properties. A-  
Chemical properties: Soil reaction pH. organic matter humification, mineralization and the fertilizing effects. Chemical data of treated soils can be obtained from complex interactions that vary notably from the initial soil data.

Soil nutrient and organic matter contents have been increased after applying olive pomace which have a positive effect on soil properties as well as plant growth performance, (Belqziz et al. [60], Buchmann et al. [61], Lanza et al. [62], Mohawesh et al. [63].

soil property values were two- to three folds higher than in the control in the amended soil treatments especially at the highest application rate ( $120 \text{ m}^3 \text{ ha}^{-1}$ ) treatment. statistical analysis showed significant decrease in the treated soils between the 2 weeks after OMW application compared with soil properties after harvesting season of 2017/2018. This could be referred to the rainfall leaching effect and plant nutrients uptake during the two growing seasons Mohawesh et al. [63]. Wafaa. E et al. [10], Results revealed no significant effect of mean pH values of different treatments compared to control. Conversely of results indicated increases of OM and CEC under effect of either bentonite or potassium humate; no significant effect was obtained among rates of nitrogen. soil conditioner (combination of bentonite and potassium humate) was favorable for soil parameters of chemical soil properties of sandy soil which reflects on increase soil fertility.

Bin Ma et al. [64] reported that, the findings demonstrated that with the increasing rates of one-time BHA application, soil profile water storage displayed a piecewise linear plus plateau increase, whereas soil electrical conductivity, pH, and bulk density were all reduced significantly ( $p < 0.05$ ) in the 0–20 cm and 20–60 cm layers. The improved soil environments gave rise to an increased activity of soil enzymes urease, invertase, and catalase that, respectively, reached peak values of 97%, 37%, and 32% of the control at the rates of 18 to  $24 \text{ Mg BHA ha}^{-1}$ .

Kwame Ampong et al. [65], Humic acids (HA) are organic molecules that play essential roles in improving soil properties, plant growth, and agronomic parameters. The sources of HA include coal, lignite, soils, and organic materials.

Humic acid-based products have been used in crop production in recent years to ensure the sustainability of agriculture production. Reviewed literature shows that HA can positively affect soil physical, chemical, and biological characteristics, including texture, structure, water holding capacity, cation exchange capacity, pH, soil carbon, enzymes, nitrogen cycling, and nutrient availability. This review highlights the relevance of HA on crop growth, plant hormone production, nutrient uptake and assimilation, yield, and protein synthesis. The effect of HA on soil properties and crops is influenced by the HA type, HA application rate, HA application mode, soil type, solubility, molecular size, and functional group.

Hassan A.M A.et al. [66], the results showed that, all vinasse and potassium k-humates combinations resulted in significantly increased shoot length, leaf number, and leaf area. All soil applications resulted in significantly lower acidity. The potassium k-humates and vinasse combinations did not have significant differences on TSS. The results suggest that soil applications of 20 g and 40 g potassium khumates with 500 mL or 1000 mL vinasse could be used to improve growth and yield of "Wonderful" pomegranate under sandy soil.

Ayman. A. [15], studied that, the soil hydrophysico-chemical properties, morphophysiological responses, yield, and quality were measured. HA addition amended the soil structure by allowing rapid macro aggregate formation, decreasing bulk density and pH, and increasing porosity and electrical conductivity, thereby improving soil hydraulic properties. HA0.2 and HA0.4 additions improved growth, yield components, and grain minerals, resulting in higher grain yield by 28.3–54.4%, grain protein by 10.2–13.4%, wet gluten by 18.2–23.3%, and dry gluten by 23.5–29.5%, respectively, than HA0. Foliar application of ZnONPs or L-TRP, especially at higher concentrations compared to the control, noticeably recorded the same positive results as HA treatments.

Further the functional of Humic acid (HA) is a major component of humic substance, produced from the biodegradation of dead organic matter, containing carboxyl and phenolic so that it behaves functionally as dibasic acid or sometimes as a tribasic acid. Functional groups which most contribute to surface charge and

**Table 11. Soil Bulk density ( $Mg\ m^{-3}$ ) of the studied soils lettuce (*Lactuca sativa L.*)**

Soil type	Treatments		B.D	
	Season	%	First	Second
Loamy	Control		0.944333 c	1.026333 b
	Olive pomace	100	1.108653 a	1.086667 a
		50	1.10915 a	1.025 b
	Vinasse	100	0.942033 c	0.902667 c
		50	0.862767 d	0.8628 e
	K- humates	100	0.8627 d	0.862717 e
		50	0.854367 d	0.863115 e
LSD <sub>0.05</sub>		1.1867	1.1866	
Sandy	Control		0.850817 a	0.811454 a
	Olive pomace	100	0.772733 de	0.772567 cd e f
		50	0.811775 bc	0.792011 b
	Vinasse	100	0.772733 de	0.731986 h
		50	0.811775 bc	0.77172 def
	K-humates	100	0.689667 f	0.7435 gh
	K-humates	50	0.770242 de	0.788954 bc
LSD <sub>0.05</sub>		1.1865	1.1864	

Bulk density ( $Mg\ m^{-3}$ ), \*\*\*Sandy soil Bulk density 1:1 \* Soil Bulk density ( $Mg\ m^{-3}$ ), \*\*Loamy soil Bulk density range :1.7 Bulk density ( $Mg\ m^{-3}$ ).1.4range

reactivity. The presence of carboxylic groups and phenolic gives the ability to form a complex with HA ions such as  $Mg^{2+}$ ,  $Ca^{2+}$ ,  $Fe^{2+}$ , and  $Fe^{3+}$ . The ability of humic acid to adsorb cations follows the lipotropic sequence, i.e.,  $Al^{3+} = (H^+) > Fe^{3+} > Fe^{2+} > Ca^{2+} > Mg^{2+} > K^+ = NH_4^+ > Na^+$  Tan, (1998). Sorption of  $NH_4^+$  is similar to  $Na^+$  Nursyamsi et al. [67]. Sorption and maximum buffering capacity of the  $NH_4^+$  and  $Na^+$  are relatively different. Cation adsorption by HA occurs through the exchange of cations in solution or that adsorbed by clay humic. Adsorption of cations or metals by HA can be through (a) direct adsorption ( $Ca^{2+}$  that release  $PO_4^{3-}$ ), (b) complexation of  $Cu^{2+}$  or outer-sphere interactions for hydrated  $Mg^{2+}$ , (c) serving as a cation bridge through direct or indirect chelation, and (d) interaction with  $Ca^{2+}$ -HA aggregates or with amine groups Sharma and Kappler [68]. Clay or humic materials have a strong affinity to weak acids containing phenolic hydroxyl, a carboxyl group, or amino sulfonyl. Alkaline cations ( $Na^+$ ,  $K^+$ ,  $Ca^{2+}$ ,  $Mg^{2+}$ ) are primarily retained by simple cation exchange with COOH groups ( $RCOONa$ ,  $RCOOK$ ) Zhang et al. [69].

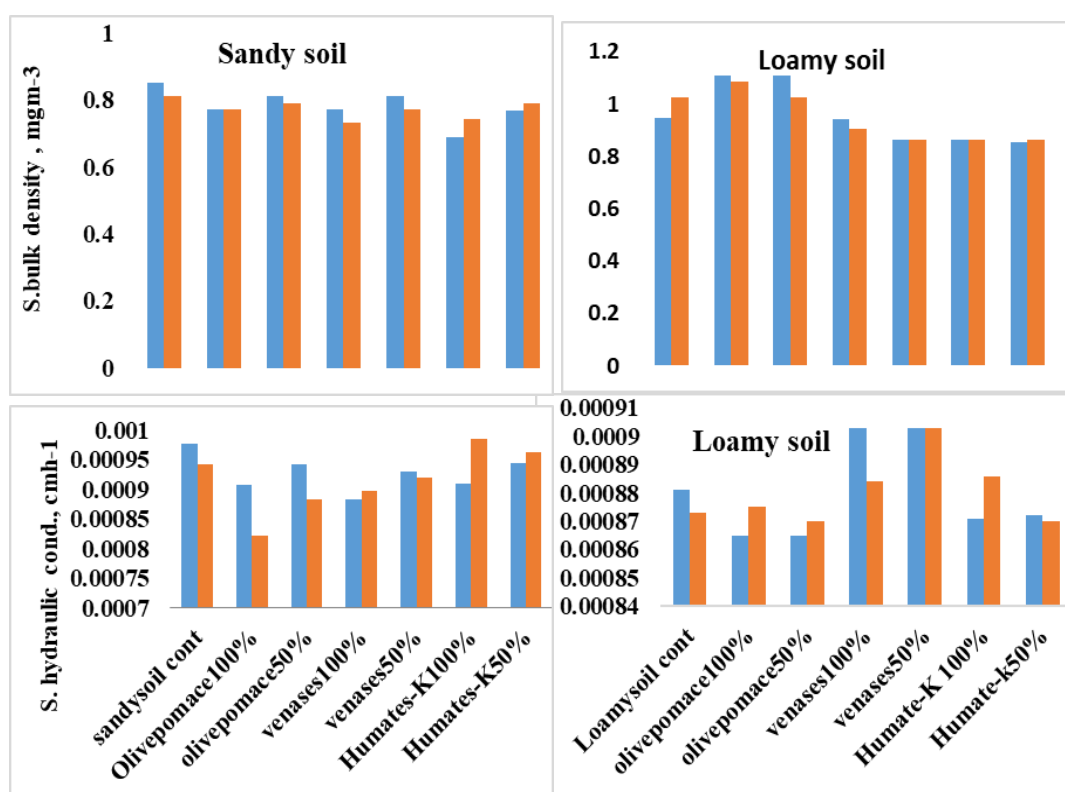
The results indicated that all treatment in Table 11 are gave significant results with each of the olive pomace50, olive pomace 100 additives compared to other additives such as Vinasse and K-humates. on other hand, sandy soil all treatments are non-significant. this due to Soil bulk density and porosity gives out the status of soil compaction Sun et al. [70]. Ze-Pu Jiang et al. [45] The results showed that, after 2–3 years of continuous vinasse application to sugarcane

fields, the soil bulk density declined, while the total porosity and capillary porosity increased in the plow layer of soil. The soil water stable aggregate content enhanced, but the soil clay content decreased and the vinasse application in sugarcane fields resulted in improved physicochemical properties of soil, and soil hardening and soil acidification were not detected in the field. The present study not only provides the basis of using vinasse as a liquid fertilizer Madejón et al. [71]. Tejada and Gonzalez [14] showed that an increase in electrical conductivity caused by high vinasse application rate adversely affects soil total porosity, bulk density, and structural stability soil physical properties can be influenced by vinasse application under different conditions from those considered in the present study such as different timescales and soil types. These changes in soil properties can have a substantial impact on runoff and soil loss from fields where vinasse has been applied Z. Hazbavi et al. [72].

Some authors reported that the application of sugar beet vinasces to soil decreased bulk density as a result of dilution of the deep soil mineral fraction (Madrid and DíazBarrientos [73], Tejada et al. [14]. All vinasces have high content of monovalent cations, which can cause dispersion of organic matter and clay particles, breaking of aggregates and soil structure. The dispersed clay particles can block pores, cause hardening of the soil upon drying, decrease water infiltration and permeability, and as consequence reduce plant growth [74].

**Table 12. Soil Hydraulic conductivity ( $\text{cm h}^{-1}$ ) of the studied soils lettuce (*Lactuca sativa L.*)**

Soil type	Treatment		Hydraulic conductivity ( $\text{cm h}^{-1}$ )		
	Season	%	First	Second	
Loamy	Control		0.000881 b	0.000873 ef	
	Olive pomace	100	0.000865 e f g	0.000875 cd e f	
		50	0.000865 e f g	0.00087 b c de	
	Vinasse	100	0.000903a	0.000884 b	
		50	0.000903 a	0.000903 a	
	K-humates	100	0.000871 d e f	0.000886 a	
		50	0.000872 d e f	0.00087 b c de	
	Sandy	LSD $_{0.05}$		1.86E-05	1.29E-05
		Control		0.000977 a	0.000942 bc
		Olive pomace	100	0.000908 c	0.000823 ef
50			0.000942 b	0.000883 def	
Vinasse		100	0.000884 d	0.000897 de	
		50	0.000931 bc	0.00092cd	
K-humates		100	0.00091 c	0.000986 a	
		50	0.000944 b	0.000964 ab	
LD $_{0.05}$			3.32E-05	5.84E-05	



**Fig. 7. Soil Hydraulic conductivity ( $\text{cm h}^{-1}$ ) and Soil Bulk density ( $\text{Mg m}^{-3}$ ) of the studied soils lettuce (*Lactuca sativa L.*)**

The results indicated that all treatment gave significant results with each of the olive pomace50, olive pomace 100 and K-humates 100 in second season additives compared to other. Due to propley, the efficient in improving the soil physical conditions Yang and Antonietti. (2020). HA with HMW have also been found to stimulate plasma membrane  $\text{H}^+$  ATPase,

allowing LMW HA to co-transport nutrients and perform other biological activities in plants [76].

### 3.5.2 \*\*Physico-chemical properties

Physico-chemical properties of olive pomace, vinasse and k-humate used in the fertilization trials. The chemical characterization of these two

wastes (Table 4) evidenced substantial showing that olive pomace contained significantly more carbon, nitrogen, conversely, Electric conductivity was not significantly different between the two wastes while pH significantly different between the two waste (Table 5). The percentage of organic matter presence in the olive pomace and vinasse were great so the use of both wastes as soil conditioner would not constitute an environmental and a healthy risk due to important of these organic matter in soils and plants. The chemical properties of both wastes fall in any case within the ranges commonly reported in literature for these materials Panuccio et al. [76], Chaari et al. [77], Moran. S. et al. [78], N. Ghorbanzadeh et al. (2020) [79-86].

#### 4. CONCLUSION

The utilization of vinasse and olive are expanding in a few agricultural ranges, substituting for natural matter, and other mineral supplements in little amounts. Single application of olive pomace, vinasse as soil conditioner affect as positively plant nutrient uptake. Regarding the low economic cost and benefits of olive pomace and vinasse as waste, it was cost effective to add for soil, by virtue of saving NPK fertilizer and increasing lettuce yield. The band application of agro-industrial waste provides an opportunity to halve NPK cost. Thus, results suggested that olive pomace and vinasse application recommended by 50%, Khumates 50%and K-humates 100% improving physical and chemical properties. They could play a fundamental role in the maintenance of rhizosphere ecosystem. Also for organic farming systems application to soils of these wastes represents an interesting option, closing the cycle of residues-resources. Further, studies should be conducted in the future to know the effect of the combined addition of vinasse, olive pomace and K-humate on the physical and chemical properties of sandy soils, as well as their effect on improving the efficiency of water and nutrient use.

#### COMPETING INTERESTS

Author has declared that no competing interests exist.

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