**Impact of some organic additives on oxidoreductase enzyme for enhancing physical and chemical properties soil and lettuce ( *Lactuca sativa L.*) yield quality**


## 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 (KH) 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 beside of enzymatic activity in soil rhizosphere of the oxidoreductase enzymes (catalase and peroxidase) 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.


**Keywords:** olive pomace wastes, vinasse and k-humate, oxidoreductase enzyme, physical and chemical properties soil, lettuce *Lactuca sativa L*. yield.




## 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 (Gerber *et al*., 2013). The increase in agricultural production affects negatively soil, air and water resources Ref.. 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 (GEF 2008), 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 Ref..

In the last decades, intensive applications of mineral fertilizers have substantially contributed to the pollution of ecosystems (atmosphere, soil and water) Ref. 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 Ref. They have little shrinking or expansion properties due to the low clay content (**Khan, 2018**). 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 (**Baiamonte *et al*. 2019**). 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 (**Galanakis; *et al*., 2017**). It wastes are commonly characterized by high levels of chemical oxygen demand (COD) and biological oxygen demand (BOD) reaching values of more than 200 and 100 g $L^{-1}$ ,respectively (**Lee *et al*., 2019**).

**Podgornik**,***et al. (*2022)** 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 ( **Debruck and Lewcki , 1990)**. in the same pattern **Vadivel *et al.* (2014)** 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.* (2016)** 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, **Seddik *et al.* (2016)** 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, and stimulate microbial diversity. **( Seleem *et al.* ,2022)**, 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. **(Chen *et al*., 2004**). Humic acids had a positive effect on plant growth, grain yield and quality, and photosynthetic metabolism of durum wheat crops (**Sebastiano *et al*. ,2005**). Humic acid is one of the major components of the humic substances (HS ). **Tejada *et al*. (2006**) 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. **Abou Tahoun *et al. (*2022)** 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 .

## MATERIALS AND METHODS

### 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.

**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-1 | $CaCO_3$ mg kg-1 |
|---|---|---|---|---|---|---|
| 7.45 | 20.85 | 30.44 | 41.26 | Clay | 7.5 | 29.0 |

| pH (1:2:5) | EC (dS/m) | Cations (mmolcL-1) | | | | Anions (mmolcL-1) | | |
|---|---|---|---|---|---|---|---|---|
| | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $HCO^{-}_{3}$ | $Cl^{-}$ | $SO^{--}_{4}$ |
| 8.03 | 2.75 | 10.90 | 5.66 | 10.07 | 0.87 | 5.65 | 12.33 | 9.55 |

| 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 |

| Parameters | Value | Available nutrients | Value |
|---|---|---|---|

**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-1 | | $CaCO_3$ mg kg-1 |
|---|---|---|---|---|---|---|---|---|
| 12.80 | 73.20 | 8.30 | 5.70 | | Sand | 6.2 | | 18.5 |
| **pH (1:2:5)** | **EC (dS/m)** | **Cations (mmolcL-1)** | | | | **Anions (mmolcL-1)** | | |
| | | **$Ca^{++}$** | **$Mg^{++}$** | **$Na^{+}$** | **$K^{+}$** | **$HCO^{-}_3$** | **$Cl^{-}$** | **$SO^{--}_4$** |
| 7.95 | 1.25 | 3.85 | 2.90 | 4.87 | 0.88 | 1.54 | 3.22 | 7.74 |
| **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 .

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

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

| Parameter | Value | Parameter | value |
|---|---|---|---|
| **pH** | 8.1 | **P mg $L^{-1}$** | 9.6 |
| **OC %** | 0.63 | **Ca mg $L^{-1}$** | 400 |
| **OM %** | 1.08 | **Mg mg $L^{-1}$** | 336 |
| **C/N** | 1.21 | **Fe mg $L^{-1}$** | 10.9 |
| **N %** | 0.52 | **Mn mg $L^{-1}$** | 1.7 |
| **K %** | 4 | **Zn mg $L^{-1}$** | 0.3 |
| **Na %** | 0.83 | **Cu mg $L^{-1}$** | 0.5 |

Waste originated conditioner**:**
Olive pomace from Olive Oil Production unit at the Horticultural Research Institute (ARC) .

**Table 3. cont..**

| | | | |
|---|---|---|---|
| **Total COD (g1-)** | **131.87** | **N (%)** | **1.63** |
| **phenols (g1-)** | **6.95** | **P (%)** | **0.13** |
| **Total Carbohydrates (g1-)** | **24.57** | **K (%)** | **2.45** |
| **Oil and gease (g1-)** | **11.14** | **Fe (mg1$^{-1}$)** | **22.45** |
| **TSS** | **34.36** | **Mn (mg1$^{-1}$)** | **8.61** |
| **pH** | **4.53** | **Zn(mg1$^{-1}$)** | **10.14** |

**Table 4: The chemical properties of the used vinasse were shown in Table as below**

| Moisture % | Color conc. | EC (dS/m | OM | HMF | K% | Density (ml/100ml) | pH | Total phenols (ppm) | P% | TN | COD mg O /L | BOD mg O /L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60.3±0.29 | 1.035 | | 4.5±0.00 | 12±0.40 | 6.4±0.15 | 54±3.1 | | 0.41±0.005 | 5.44±o.65 | 3.05 | 48500 | 22500 |

**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.(1982)** and **Klute (1986) as follow: . Electrical conductivity (EC)** was determined in the soil paste extract by electrical conductivity meter soil electric conductivity (EC, dSm-1) was determined according to **Rhoades (2018).* Soil pH** was measured in 1:2.5 soil: water suspension using a pH meter

The so.il pH values were measured according to **Thomas (2018)** .

*Soluble carbonates and bicarbonates were determined in a soil paste extract by titration against 0.01M sulphuric acid in presence of phenolphthalein(ph th) and methylorange (MO) indicators, respectively.

*** Calcium and magnesuim** 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 (0.01*M*) 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.1982).**

*** The Organic matter** was determinate by the Walkely and Black method

.

*** Cation Exchange Capacity (CEC) was** determined using ammonium acetate (pH= 7) and sodium acetate (pH=8.2) according **to (Page et al.1982).**

*** Exchangeable sodium was** determined using ammonium acetate.

**Bulk density** was determined soil samples according to **(Plaster,.1985) method (clod method).**

****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 **(Hussein et al.2012).**

*****Hydraulic conductivity** was conducted using falling head method according to**(Klute1986).**

, the governing equation is: -

$$K=(al\backslash At)\ In\ (H_1\backslash H_2)$$

Where:
a= is the area of cross section of the stand pipe.
l=is the length of the sample.
A=is he cross sectional area of the sample
t= is the time for the hydraulic head difference to decrease from $H_1$toH2.

**Pot experiment.**

The pots experiments were two-pot experiments clayey and a sandy have been cultivated in in pots with size capacity of 10 kg soil (I 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: $P_2O_5$: $K_2O$ as mentioned by **El-Mogy *et al*. (2020).** The mineral NPK fertilizers used in this study were ammonium nitrate (33%N), calcium supper phosphate (15.5% $P_2O_5$) and Potassium sulfate $K_2SO_4$ (48% $K_2O$) as Egypt ministry of agricultural recommended . Calcium supper 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.

**Table 5: The layout of the experimental design.**

| Soil | Treatment. | % | symbol |
|---|---|---|---|
| The Fine textured soil | Control | 0 | T1 |
| | Olive pomace | 100% | T2 |
| | | 50% | T3 |
| | vinasse | 100% | T4 |
| | | 50% | T5 |
| | K- Humate | 100% | T6 |
| | | 50% | T7 |
| Sandy The coarse textured soil | Control | 0 | T1 |
| | Olive pomace | 100% | T2 |
| | | 50% | T3 |
| | vinasse | 100% | T4 |
| | | 50% | T5 |

| | | |
|---|---|---|
| Humate-K | 100% | T6 |
| | 50% | T7 |

The other agricultural practices were done according to the recommended methods for lettuce crop **(El-Ghinbihi, and Mahmoud, 2007).** After harvest, both lettuce and soil samples were collected for determination of yield parameters, chemical and biochemical properties.

**Chemical analyses of the olive pomace, vinasse and potassium** K-humates:

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 (1959)**. HMF was determined as mentioned by **Zappalaa *et al*. (2005**). Total nitrogen, $K_2O$ and $P_2O_5$ were determined as described by **A.O.A.C. (2000).**

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

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.* (1982).** Total nitrogen (T.N) was determined by the Kjeldahl method **(Cottenie *et al*., 1982).** Organic carbon was calculated according to (**Page *et al.*, 1982), Soil biological activities Quantitative determination of enzymatic activity in soil rhizosphere Some** biological activities were determined in collected soil samples from lettuce rhizospheres at periods of 55 days from planting.

**1-Dehydrogenase activity (E.C 1.1),** was measured according to (**Thalmann ,1968)**

**2-Nitrogenase activity** (E.C.1.18.6.1) was measured by acetylene reduction assay as described by (**Johnsen and Apsley, 1990**).

**3-Phosphatase enzymes (E.C 3.1.3)** was measured by **(Tabatabai and Bremner, (1969).**

The soil mixture was chemically analyzed before plantation and pH, EC, water holding capacity (WHC), organic matter content, NPK, cations and anions were determined to have a complete knowledge about the experimental conditions (**Jackson, 1967**)

**4- peroxidase activity (POX)** The activity of peroxidase (EC 1.11.1.7) was assayed according to (Kar **and Mishra 1976).**

**5- catalase activity (CAT)** Catalase (EC 1.11.1.6) was measured according to (**Goth ,1991).**

**Chemical Characteristics of Vegetative Growth:**

Macro-elements: Nitrogen (%) was estimated according to **(Pregl ,1945)** using the modified micro Kjeldahl method. According to **(Snell and Snell ,1967**), phosphorus (%) was calorimetrically measured. Potassium (%) was determined according to **(Jackson**,**1967**) using Flame photometry instrument. Chlorophyll a, chlorophyll b and carcinoids were estimated according to **Lichtenthalerand Wellburn (1983).**

**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 lettuce were collected randomly for this measured. The percentage of total soluble solids (TSS) in each fruit juice sample was determined using a hand refractometer, **(A.O.A.C ,2000).**

**2.7. 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 **(Stern, 1991**).

## Results and Discussion

**Fertilizer efficacy on leaf nutrient and antioxidant enzyme   Leaf nutrient concentrations**

Significant treatment influences were recorded for leaf N, P and K Contents **(Fig.2)**. 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.2)**, with non-considerable 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.

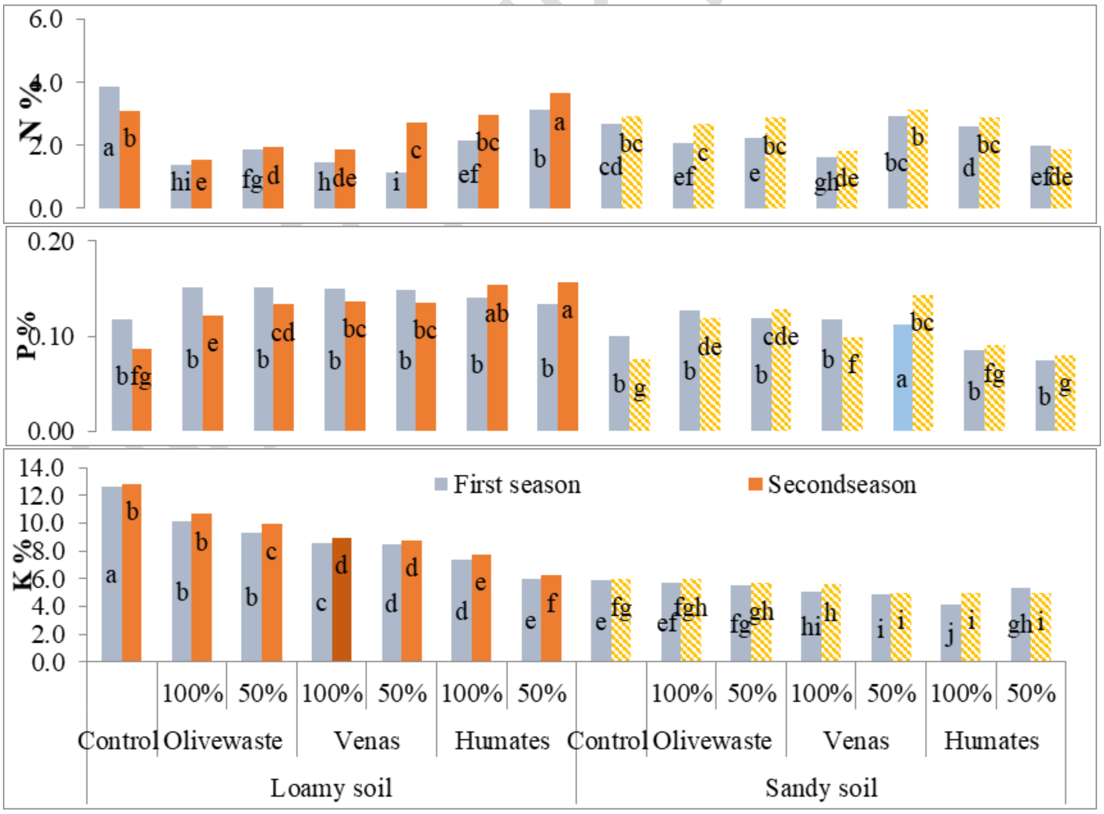
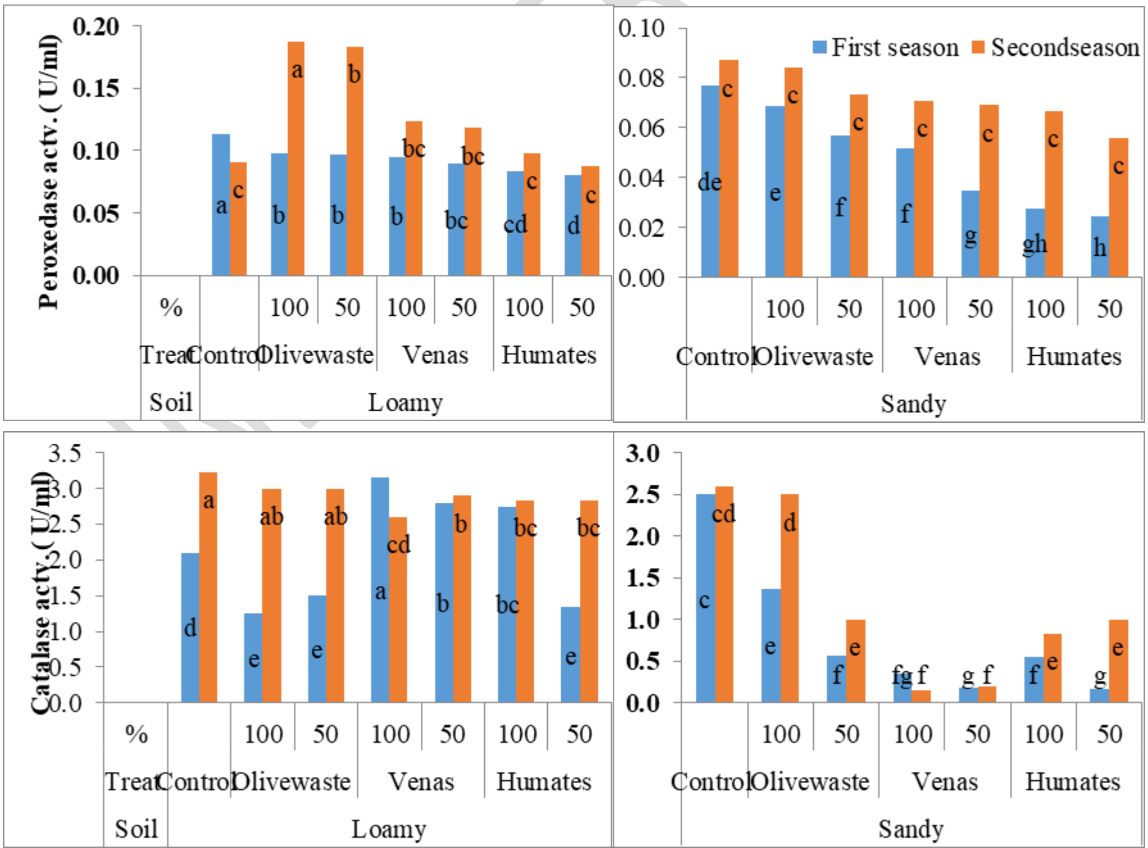


**Fig 1. Effect of vinasse, olive pomace, and potassium humate, additive in both loam and sand soil on macronutrient concentration in lettuce leaves**

In both seasons all treatment whether in loam and sand soil resulting in significantly higher leaf K concentrations than the control. Fig. (2). Previous studies have reported that leaf nutrient concentrations were increased with aground 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*.(2014 ),Mansour;2008**).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 (**Mirdad,2016**). on the other hand, humic substance application has been resulted in decreased pH on the root surface, thus facilitating the uptake of H+/NO3 symports, availability of $NH_4^+$ and enhance N organic compounds in plants, by enhancement activation of glutamine synthetase and glutamate synthase enzymes increased leaf amino acids content. While, vinasse application increased plant nutrients concentration **Schiavon; etal, (2010**).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.(**Gómez-Muñozes *al*.2011; Ali ,*et al* .2021**)

**Additive waste Effects on Enzyme Activities**

Extra or intracellular enzymes play an important role in maintaining loamy and sandy ecosystem quality functional diversity, and nutrient cycling **Sinsabaugh *et al*., (2002).**

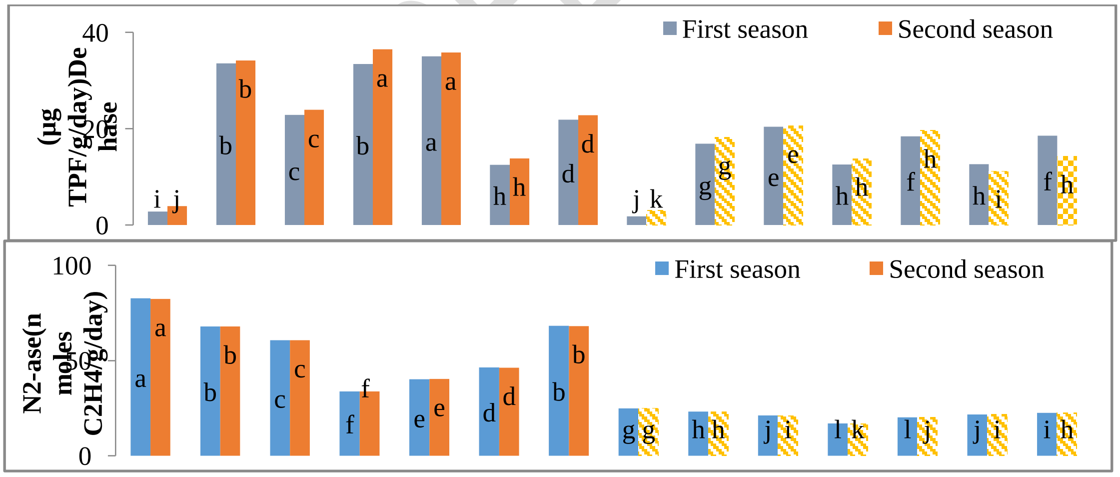



lower than control. On the other hand, peroxidase activity was significantly increased in olive treatment in first season in loam soil while in sand soil inhibited in the olive pomace and vinasse amended soils. Catalase and peroxidase are an oxidoreductase associated with aerobic microbial activity **Rodrı´guez-Ka´bana and Truelove, (1982)** and its activity was significantly and positively correlated with dehydrogenase in the loam soil. Sandy soil showed no significant differences between treatments. Catalase activity was higher in the two concentration treatments of venase in loam soil being stimulated the synthesis of this enzyme by the addition of vinasse residues. This result may be explained by the improved soil aeration in the byproduct amended soils as a consequence of an increase in soil total porosity **Bin Ma *et al.*, (2022).**

**Table 6. correlation of oxidoreductase enzyme with dehydrogenase activity**

| Season | | First | | Second | |
|---|---|---|---|---|---|
| Soil type | | Peroxides | Catalase | Peroxidase | Catalase |
| Lomy | D.H.A. | -0.3 | 0.1 | 0.5 | -0.6 |
| Sandy | | -0.5 | -0.8 | -0.3 | -0.4 |

Enzyme activities varied widely among the treatments studied. The treatment in which the highest activity occurred was found to vary depending on the enzyme (Fig. 2). Basically, enzymes involved in Intracellular microbial metabolism, such as dehydrogenase and phosphatase increased with the addition of vinasse and olive pomace. While the result of nitrogenize estimation was negligible. The highest values for dehydrogenase activity was found in the vinasse followed by the olive pomace treatments that followed by k-humate in loam and sandy soil. A correlation matrix (Table 13) shows some significant relationships between the enzyme activities studied in the residual soil. There was a strong positive correlation in the accumulative soil between intracellular enzyme activity, which are involved in soil C mineralization dehydrogenase showed a positive correlation with phosphatase and both enzymes had a negative correlation with nitrogenize activities.



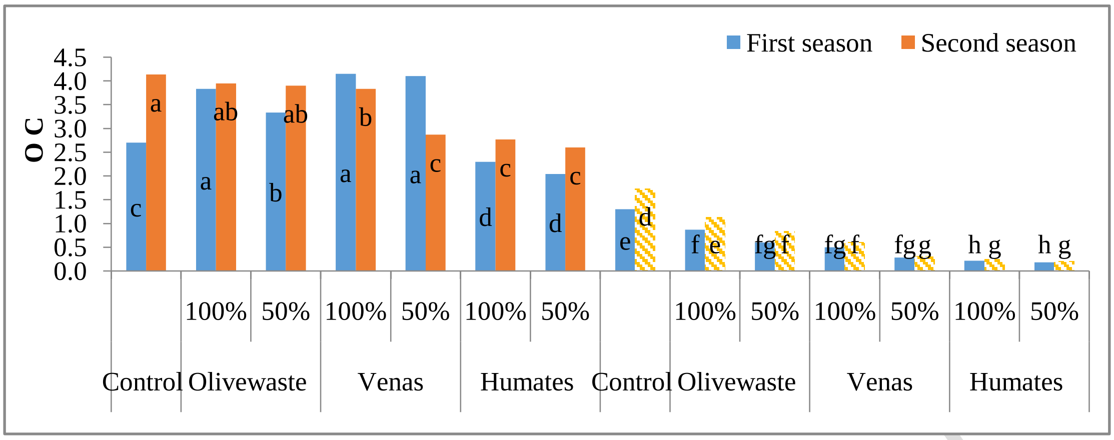



**Fig 3. Soil enzyme activity under vinasse, olive pomace and k-humate additive in loam and sand soil**

From our data this is obviously in all treatments the loam soil is more affected by additive treatment than sandy soil. Correlation among enzyme activities Dehydrogenase and nitrogenize are extratra cellular enzymes that are involved in microbial oxidoreductase metabolism. The activity of such enzymes basically depends on the metabolic state of the soil biota. Dehydrogenase activity was significantly correlated with soil biomass C in both loam and sand soil. P 0.05.: This means that dehydrogenase activity could be a good indicator of soil microbial activity in soil treated with industrial byproduct (**Garcı´a-Gil, *et al*. 2000** ).A significant increase in dehydrogenase activity occurred in the soil with by-product treatments, especially with 50% olive and 50%vinasse . Both rates of them had greater activities than higher concentration; presumably due to the higher concentration of matter added is more resistant to microbial growth.

**Table 7. correlation between soil enzymes activity**

| Seasone | | **First** | | **Second** | |
|---|---|---|---|---|---|
| Soil type | | **N2- ase** | **Photase** | **N2- ase** | **Photase** |
| **Lomy** | **D.H.A.** | -0.6 | 0.8 | -0.6 | 0.8 |
| | **N2- ase** | | -0.6 | | -0.7 |
| **Sandy** | **D.H.A.** | -0.3 | 0.9 | -0.4 | 0.9 |
| | **N2- ase** | | -0.3 | | -0.3 |

Other authors have reported that dehydrogenase activity was inhibited by the toxic effect of total phenol and hydroxylmethylforforal added with an by product amendment, also Phenolic compounds being released during both the plant vegetation and decomposition of soil additive matter contribute to a reduction in the biological activity of the soil **Natywa *et al*. 2014**, López-**Piñeiro, *et al*.** (**2011).**

Changes in soil phosphatase activities, which play an essential role in the mineralization of organic phosphorus, were also observed between treatments. Both phosphatase and nitrogenize activities were significantly correlated (-0.6, -0.7) respectively in the loamy soil. Phosphatase was inhibited in 100% oliveand%100 vinasse amended soils while the K-humate Fertilization and the control treatments exhibited an increase in this enzyme activity. In the sandy soil, phosphatase slightly decreased in all treatments than loam soil. Generally, this enzyme is activated when there is low P availability in soils. Phosphatase can be inhibited by the type of amended to soil, which produces a feedback inhibition of this enzyme. This may explain why the higher concentration of olive pomace and vinasse give the lowest enzyme activity. Overall, our results have shown that the addition of organic residues to an agricultural soil has a variety of effects on microbial biomass and enzyme activities. These two important soil properties respond to soil perturbation or restoration over a relatively short time. Soils amended with MSW compost can improve soil quality, increasing the organic matter content of degraded soil sand improving soil biological and biochemical properties. However, the wide variety of substances such as heavy metals and other potential pollutants in municipal solid wastes limits the use of these residues in compost. Consequently, there must be a quality control of these organic amendments in order to minimize the risk of inhibiting essential biogeochemical processes as well as contributing to environmental pollution.

**Physiological parameters**

**Photosynthesis content:** The ground additive of olive and vinasse waste as soil conditioner significantly affected total chlorophyll and carotenoids contents (**Fig.3**). Concentration caused considerable increases 50% of olive pomace and 50,100% k-humate in total chlorophyll by251,212,199,282,250,211%, respectively in two periods in loam soil. Concurrently with sand soil 227,186,225,228,169,224% respectively. On the contrary, the decrease was in the results of the following treatment vinasse50% in loam soil and olive pomace 100% in sand soil. 75, 45, 41, 63% respectively. While olive 50%and k-humate100% exhibited the highest contents of carotenoid pigments in loam soil (**Fig.3**). It was noticeable in the sand soil there was inconsiderable change between treatment and non- treated control. (**Fig.3)**

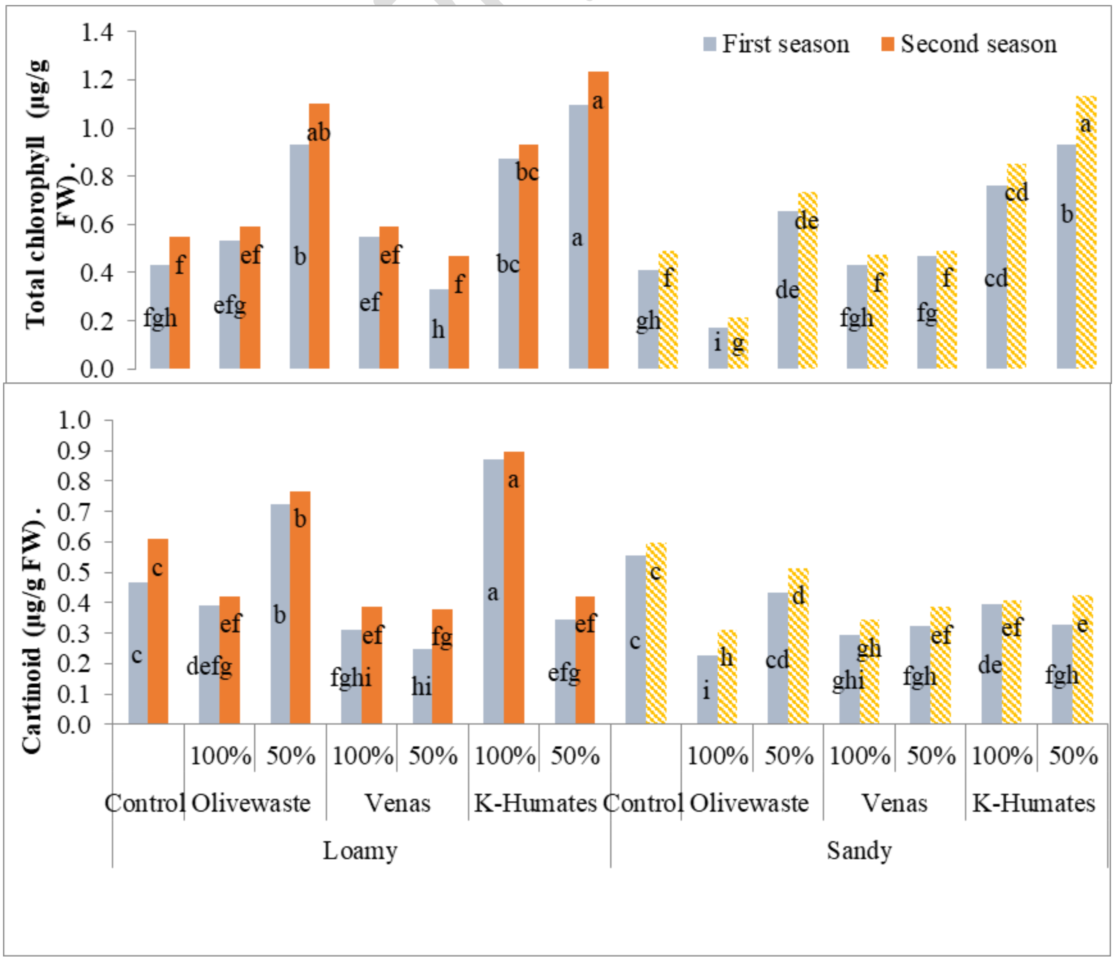


**Fig 4. Effect of different concentration of olive pomace, vinasse and k-humate on photosynthesis pigment content (µg/g FW) of lettuce planet growing in loamy and sandy soil**

Chlorophylls are the primary pigments and are directly involved Photosynthetic Pathway. Mainly used in photosynthesis to capture light and generate carbohydrates**.**
Leaf chlorophyll concentration has been linked to plant nutrient status. As a component of chlorophyll molecule, nitrogen is a major nutrient affecting leaf chlorophyll concentration. In the greenhouse trial, leaf chlorophyll index at loam soil was not significantly affected by treatments, indicating that a significant proportion of absorbed nitrogen during the early stages of plant growth may have been used to generate structural elements of the plant rather than chlorophyll as suggested by several authors **Lacolla,** ***et al*****.** (**2019**). Moreover, the significant difference in chlorophyll concentration at sand soil could be related to the faster N mineralization of olive pomace-based fertilizer in comparison to other treatments and to the high plant demand of nitrogen during the exponential phase of plant growth **Lawlor,** ***et al*****.** **(2004**). On the other hand, the non-significance among all treatments at sand soi could be explained by the low N demand by the lettuce plants during this final growth stage. Lettuce quality traits such as chlorophyll and nitrate contents were also improved with application of several organic fertilizers such as bio digested vinasse, digested livestock manure, rice bran and molasses **Santos,** ***et al.*** **2010**, **Liu,** ***et al*****.** (**2014**) . Additional studies demonstrated that soil application of organic materials like food waste compost, garlic stalk by-product enhanced soil enzyme activity in lettuce cultivation (**Lee,2004** , **Wojewódzki,*et al.*** **2022**).
Positive correlations between leaf nitrogen and chlorophyll content have been reported in several studies **Ding *et al*., 2005; Damata *et al*., (2002).** Yield and its attributes Vegetative growth.

**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 agro-industrial waste had significant effects on lettuce yield fig 4. 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%respactively)in season one and recorded(168, 153, 154%). likewise, in sand soil compared to other treatments in two season 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.
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 **(Fig2)**. These might be due to improve physical and chemical properties of olive and vinasse additive that were discussed earlier Table (8,9,10,11). **Rahman** ***et al*****.** **(2017)** reported that fresh weight of lettuce increased with increasing the volume of nutrient applied. **Michael and Lieth (2008)** 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*****.** **(2005**) also stated that EC levels above 2.0 and 2.6 dS $m^{-1}$ reduced fresh yield and plant growth, respectively in lettuce.

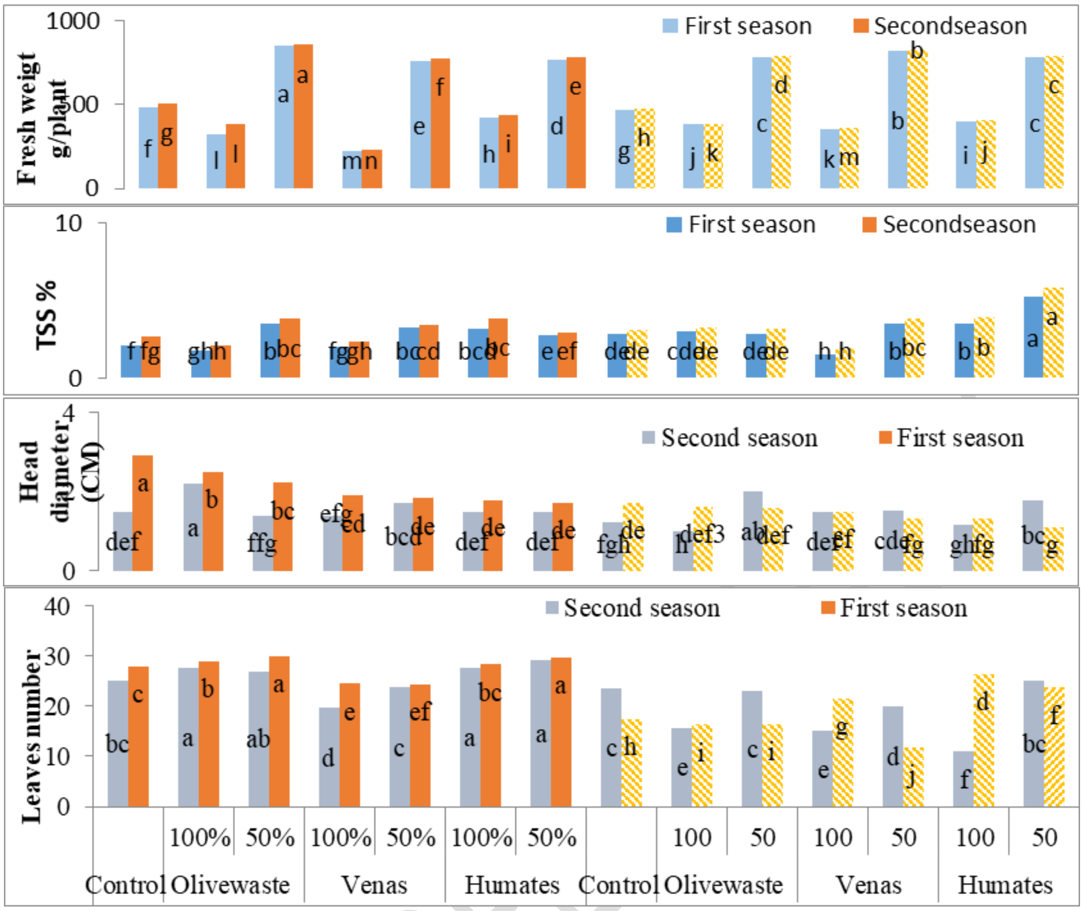


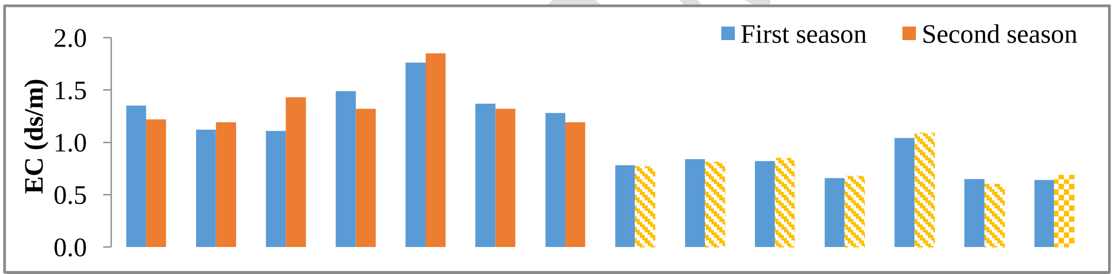

**Fig 5: Effects of additive waste on fresh weight,TSS%,head diameter and number of leaf of lettuce at harvesting time.**

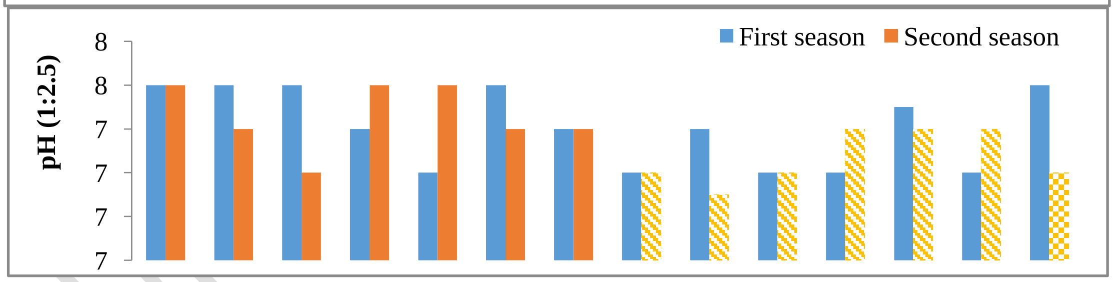
Soil application of vinasse and olive pomace with different concentration Increased significantly growth and yield of lettuce.so they could play a fundamental role in the maintenance of the rhizosphere ecosystem. Also for organic farming systems application to soils of these wastes represents an interesting option, closing the cycle of residues-resources (**Roig *et al*., 2006**) 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.

**Table 8. Characteristics with each treatment waste (olivepomace, vinasse) and K-humate understudy.**

| Char act<br>Treatments | pH | EC (ds/m) | hydroxyl methyl forforal (mg/ g sample) | Total phenols (ppm) mg phenol./100 g | N | P | K | Organic Matter |
|---|---|---|---|---|---|---|---|---|
| | | | | | | % | | |
| **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 |

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 9 fig. 6)



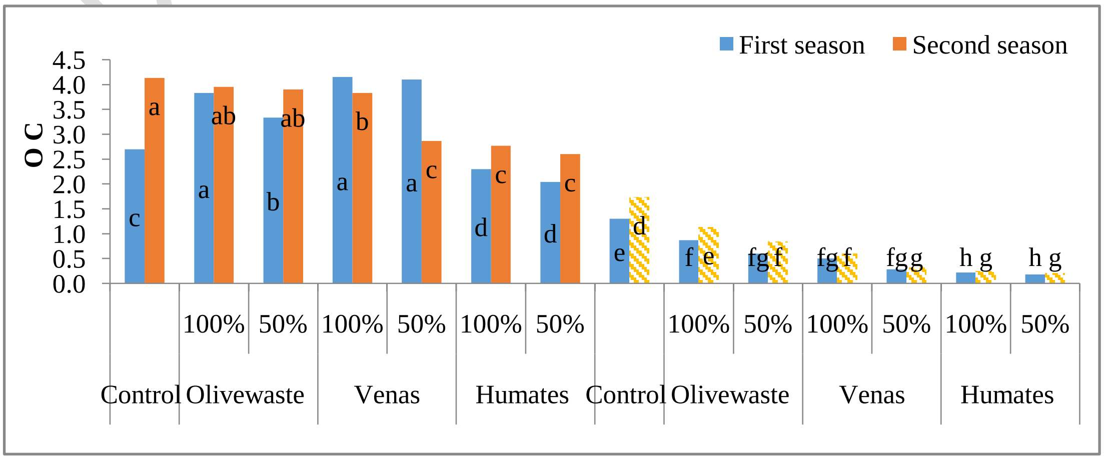



**Fig 6. Changes in loam and sand soil properties after olive pomace, vinasse and k-humate application.**

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 (1) .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 6)** 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, **(Table9)**. 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 **table (10,11,12,13)**. 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

**(Cardarelli, *et al*. (2023), Chang *et al*, (2008) and Tittarelli, *et al(* 2017).** 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.

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.

**Table 9. Some Chemical properties of the studied soils lettuce (Lactuca *sativa L.*).**

| Soil type | Treatment | | EC (μs/cm) | | pH (1:2.5) | | 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 $_{0.05}$ | | 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 $_{0.05}$ | | 0.5 | 0.49 | 0.14 | 0.14 | 2.3 | 2.35 | 0.22 | 0.22 |

EC, Data presented in table (5) 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-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.*, (2009) (Wafaa Seddik *et al.*, 2016).** 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 treatment 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 (5) 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+ act as electron acceptor) and high content of free hydrogen ions **(Jiang *et al.*, 2012). (Wafaa Seddik *et al.*, 2016).** 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 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. El-Etr *et al.*, ( 2016)**.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.*, (2008).**

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.*, *(*2012). Leïla Chaari et., *al* (2014)**, 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 m3 ha-1, were noted to increase in comparison to the control. The pH increase did not exceed 0.5 units for the soil treated with 200 m3 ha-1 in relation to the control soil. **Mekki *et al.*, (2007)** reported that pH does not vary according to the depth. **Magdich *et al.*, (2013)** 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-1), except for soil samples treated with 100 and 200 m3 ha-1 in the upper layer. These results were consistent with previous works, reporting EC increases during the irrigation times **(Chartzoulakis *et al.*, 2010; Kavvadias *et al.*, 2010; Moraetis *et al.*, 2011; Di Bene *et al.*, 2013), Leïla Chaari et al., (2014). Soha R.A. Khalil *et al.*, (2020**), 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 venase50-100 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. Seddik *et al.*, 2016**). reported that, so that, this may be due to vinasse relatively high content of organic matter**. (Biswas *et al.*, 2009).** 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 (2002) 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 (2). (Biswas et al., 2009). 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 (2002)** 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.*, (2014),** 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 m3 ha-1 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 m3 ha_1 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 El-Etr et al., (2017),** 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 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 HK 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. **(Dejou 1987 and Amjad et al. 2010). Also, Croker *et al.*, (2004)** 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.

**** physical properties:**
Data presented in table (6) showed that, The results presented in Tables (6), (7) 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 welting 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 Seddik (2016)**, 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 **(Tejada *et al.*, 2007). Jiang *et al.*, (2012)** 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.*, (2011)** 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.*, (2012)** 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.

**Table 10. 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 $_{0.05}$ | | 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 | **75.14 e** | 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 $_{0.05}$ | | 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).

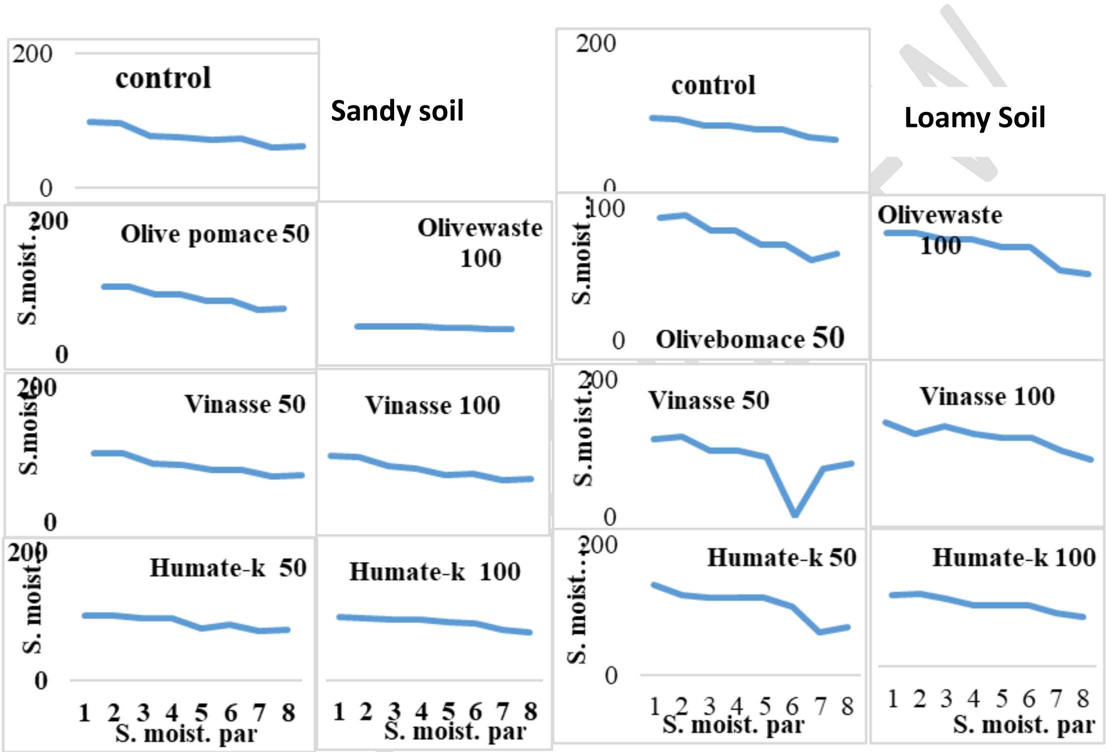



**Fig 7. Soil moisture contents (%) in two type soils as affected by the soil amendments and plants grown thereon**.

Data presented in table (8) showed that, The results presented in Tables 7, 8showed 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-humates100 is significant as comparative with control and all treatment and welting holding point WHP the results indicate that treatment of K-humates100 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 M.A. Seddik (2016)**, 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 **(Tejada *et al.*, 2007). Jiang *et al.*, (2012**) 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.*, (2011**) 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.*, (2012**) 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.

**Table 11.** 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 $_{0.05}$** | | 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 $_{0.05}$** | | 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).

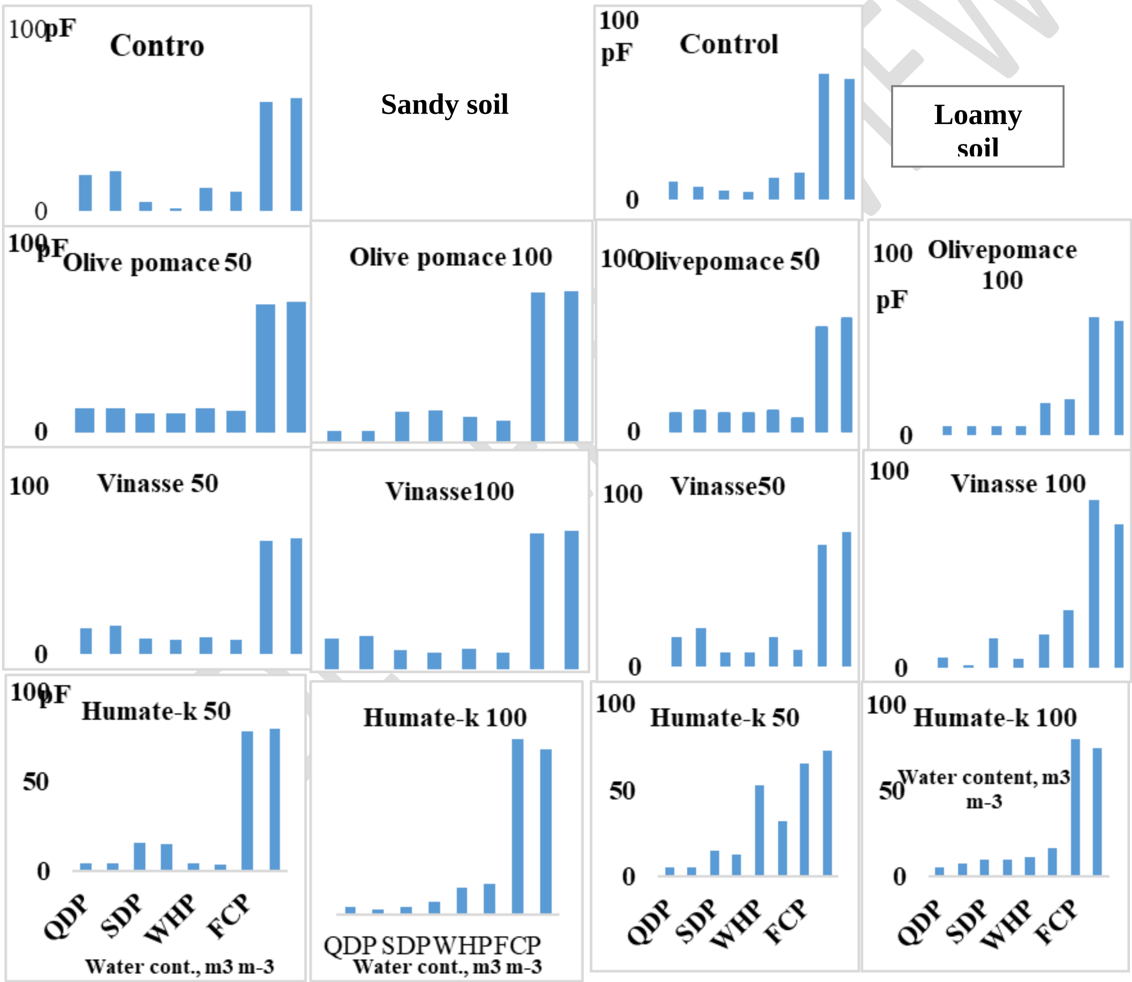



**Fig8.** Pore size distribution of the studied soils **lettuce (Lactuca *sativa L.*)**

The results indicated that all treatment gave non-significant 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: 1- 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.* 2016; Buchmann *et al.* 2015; Lanza *et al.* 2017; Mohawesh *et al.* 2014).

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 m3 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*., (2019**). **Wafaa El-Etr *et al*., (2017),** 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*., (2022)** 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, inverts, and catalase that, respectively, reached peak values of 97%, 37%, and 32% of the control at the rates of 18 to 24 Mg BHA $ha^{-1}$.

**Kwame Ampong *et al*., (2022),** 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 AM Ali *et al*., (2021),** 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 k-humates with 500 mL or 1000 mL vinasse could be used to improve growth and yield of "Wonderful" pomegranate under sandy soil.

**Ayman Abou Tahoun (2022**), studied that, the soil hydrophysico-chemical properties, morpho-physiological 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 reactivity. The presence of carboxylic groups and phenolic gives the ability to form a complex with HA ions such as Mg2+, Ca2+, Fe2+, and Fe3+. 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.*, (2009).** 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, (2011).** 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.*, (2013).**

**Table 12. Soil Bulk density (Mg m$^{-3}$) of the studied soils lettuce (Lactuca *sativa L.*)**

| Soil type | Treatments<br>Season | % | B.D<br>First | Second |
|---|---|---|---|---|
| | **Control** | | 0.944333 c | 1.026333 b |
| | **Olive pomace** | **100** | 1.108653 a | 1.086667 a |
| | | **50** | 1.10915 a | 1.025 b |
| **Loamy** | **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 |
| **$LSD_{0.05}$** | | | 1.1867 | 1.1866 |
| | **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 |
| **Sandy** | **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 |
| | **$LSD_{0.05}$** | | 1.1865 | 1.1864 |

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

The results indicated that all treatment gave significant results with each of the olive pomace50, olive pomace 100 additives compared to other additives such as Vinasse and K-K-humates . on other hand, sandy soil all treatment are non-significant. this due to Soil bulk density and porosity gives out the status of soil compaction **Sun *et al.* (1999). Ze-Pu Jiang *et al.* (2012)** 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. (2001). Tejada and Gonzalez (2005)** 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.*, (2016).**
Some authors reported that the application of sugar beet vinasses to soil decreased bulk density as a result of dilution of the deep soil mineral fraction (**Madrid and DíazBarrientos (1998); Tejada *et al.*, (2007)**. All vinasses 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 **(Mavi *et al.*, 2012).**

**Table 13. Soil Hydraulic conductivity (cm $h^{-1}$) of the studied soils lettuce (Lactuca *sativa L.*)**

| Soil type | Treatment | | Hydraulic conductivity (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 |
| | LSD $_{0.05}$ | | 1.86E-05 | 1.29E-05 |
| Sandy | 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 |

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 H+ ATPase, allowing LMW HA to co-transport nutrients and perform other biological activities in plants **(Nardi *et al.*, 2021).**

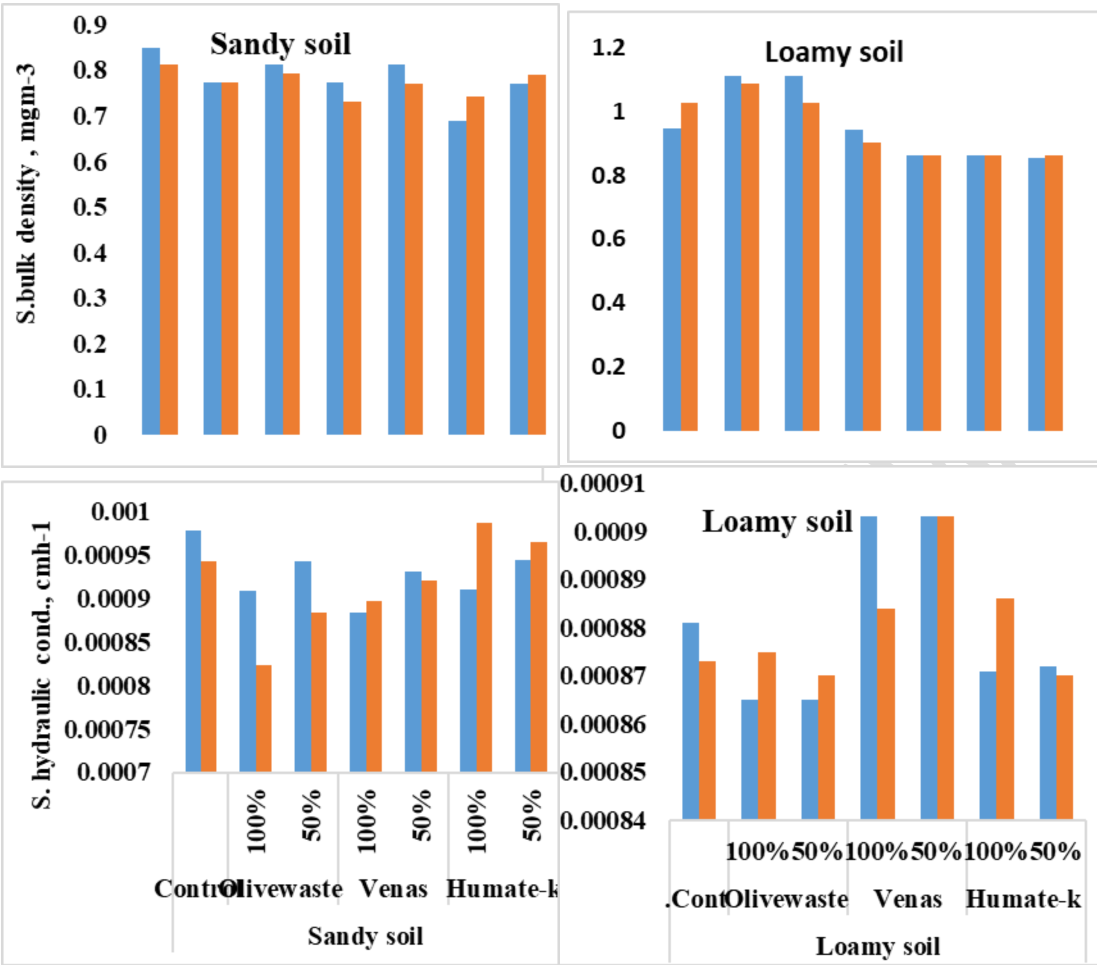



**Fig 9.** Soil Hydraulic conductivity (cm $h^{-1}$) and Soil Bulk density (Mg $m^{-3}$) of the studied soils lettuce (Lactuca *sativa L.*)

Physico-chemical properties of olive pomace, vinasse and k-humate used in the fertilization trials. The chemical characterization of these two wastes (Table 2) evidenced substantial showing that olive pomace contained significantly more carbon, nitrogen, Total phenols and hydroxylmethylforforal , conversely vinasse contained a greater amount of hydroxylmethylforforal and Total phenols. The content of Total phenols in K-humates was low or negligible. Electric conductivity was not significantly different between the two wastes while pH significantly different between the two waste (Table 1). 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*. (2022 ),chaari;*et al* (2014), Moran‐Salazar *et al.(*2016), Ghorbanzadeh ,*et al*.(2020).**

## 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%., K-humates 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, biological and chemical properties of sandy soils, as well as their effect on improving the efficiency of water and nutrient use.

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