J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 10(1): 69 - 77, 2019

Effects of Sugar Beet Factory Lime, Vinasse, and Compost Mixed with Vinasse Application on Sandy Soil Properties and Canola Productivity

Kheir, A.M.S. [1] and M. M. Kamara [2]
[1] Soils, Water and Environment Research Institute; Agricultural Research Center, Giza, Egypt
[2] Agronomy Department, Faculty of Agriculture, Kafrelsheikh University, Kafr El-Sheikh, Egypt

ABSTRACT

Large amounts of sugar industrial wastes such as sugar beet factory lime (SBFL) and vinasse (V) are producing annually causing some problems to the environment if not exploited or recycled. Sandy soils and new reclaimed soils are suffering from lack of water retention, low fertility and thus low productivity, requiring more attention to maximize their water and nutrients supply potentials using new and low-cost soil conditioners. Therefore, it was though useful to use sugar factory by products in solving such problems in sandy soils. For this purpose, a field experiment in a completely randomized experimental design with three replicates was conducted through two successive growing seasons (2016/2017 and 2017/2018) in sandy soil, to study the effect of SBFL at a rate of 10 t/ha, V in irrigation water (5 ml/L) and compost mixed with vinasse, CMV at 1:1 rate on some selected soil physico-chemical properties and canola productivity. Results showed that, application of CMV followed by V and SBFL significantly increased soil organic matter, soil available macro-nutrients (N, P and K) and water holding capacity. Meanwhile, soil bulk density and hydraulic conductivity values were decreased subjected to conditioners application, confirming their suitability in improving sandy soil properties for sustainable agriculture. Consequently, canola seed yield, oil and protein content increased significantly due to CMV, V and SBFL application. From view point of water, the highest values of canola water productivity were obtained under CMV application followed by V and SBFL compared with control, favoring their suitable use to get more crop with less drop in sandy soils. Economically, application of SBFL achieved the higher seasonal net return and benefit cost ratio with lower specific cost followed by V and CMV respectively. The study, therefore recommends using CMV to improve the sandy soil properties and its productivity, despite its relatively low economic return compared to other conditioners, given the high-water productivity of CMV application and alleviating the high salinity of V application.

Keywords: Sandy soils, sugar beet lime, vinasse, compost, water productivity, canola, economic evaluation

INTRODUCTION

Sandy soils with low colloidal content are suffering from lack of water and nutrient supply potentials (Głąb *et al.,* 2018), high infiltration rate, high evaporation, low organic matter content and excessive deep percolation (Kheir *et al.,* 2017), reduction in its productivity as well. Appropriate soil conditioners could be used to tackle these problems through improving the retention capacities and allow plants to get their water and nutrient requirements easily. Different organic and inorganic amendments were recently used to improve sandy soil properties and crop production such as bentonite, polyacrylamide, and compost (Kheir *et al.,* 2017), Nano hydroxy apatite, biochar and sugar beet factory lime (SBFL) (Seleiman and Kheir, 2018a), and bagasse ash (Seleiman and Kheir, 2018b).

Sugar beet factory lime (SBFL) is generally produced and stockpiled close to sugar factories during sugar beet juice purification process (Sims *et al.,* 2010, Shaheen and Rinklebe, 2016, Seleiman and Kheir, 2018a). The (SBFL) is one of the lowest cost sorbents, and considered an organic amendment (Shaheen and Rinklebe, 2016), contains high content of total Ca, Mg, N, P and K (Sims *et al.,* 2010).

However, using SBFL in improving sandy soil properties not studied before, favoring its importance in current study.

Vinasse (V) is a liquid disposal generated during ethanol production and molasses fermentation from either sugarcane or sugar beet in sugar factories has specific benefits to soils if it used as soil conditioner (Morgan-Salazar *et al.*, 2016). It is characterizes by acid pH, dark color, high electrical conductivity (EC), higher organic matter content, high concentrations of suspended solids (CETESB., 2006). Also, vinasse could be used as a fertilizer due to its high nutrient content (i.e. calcium (Ca) and potassium (K) as well as its higher content from organic materials (Morgan-Salazar *et al.,* 2016). Due to the prevailing of monovalent ions in vinasse, it can cause dispersion of organic matter (OM) and clay particles, destroying aggregates and soil structure in salt affected soils. Consequently, soil pores would be blocked by fine particles, decreasing water infiltration rate and permeability (Mavi *et al.,* 2012).However, Vinasse application in sandy soil has less attention so far, requiring an urgent study of vinasse on sandy soil properties and crop production.

Composting process has become increasing popular in sustainable agriculture, as compost increases soil organic matter, and nutrients, creating a positive effect on soil physical, chemical and biological properties (Hargreaves *et al.*, 2008, Głąb *et al.,* 2018). The importance of co-composting vinasse with rice and cotton straw will overcome problems created from vinasse such as high salt content, low phosphorus content and higher density.

Canola (*Brassica napus* L.) has been identified as a promising crop for production in Egypt to increase the country's edible oil supply. Over the last decades, canola has become a crop of high global agro-economic importance, featuring a wide range of uses for food, feed and fuel purposes. It currently holds the third position among oil crops after palm oil and soybean (FAO., 2018). Canola has proved potential to be productive in Egypt even under salinity, heat and drought stress in newly reclaimed arable land outside the Nile valley (Abdallah *et al.,* 2010). An increase in Egyptian canola production may further help to interrupt the cereal-dominated crop rotations, reduce the pressure of soil-borne cereal pathogens and increase subsoil macro-porosity due to its deep tap root system (Abdallah *et al.,* 2010). The expansion of canola cultivation is therefore a major forthcoming target of the Egyptian Government toward its 2030 agricultural strategy plan(MALR., 2014), to tackle the shortage in edible oil production.

Based on the above view, the objective of this investigation was to explore the effects of using new low-cost soil conditioners (i.e. SBFL, V, and CMV) on improving sandy soil physical and chemical properties. Moreover, to study effect of such amendments on canola productivity grown in sandy soil.

MATERIALS AND METHODS

Study site and soil properties

A field experiment was carried out in a sandy soil at Baltim district, Kafrelsheikh Governorate, Egypt (31° 33 40.4 Latitude and 31° 19 52.5 longitude) with 2.5 m elevation above sea level. Soil samples before sowing were taken for chemical and physical analysis (Tables 1).

Table 1. Chemical and physical characteristics of the studied soil before cultivation

Item	value	Item	Value
Soil chemical properties			
EC (dS/m)	1.3	Cl^- (meq/L)	13.3
pH	7.9	SO_4^{-2} (meq/L)	1.6
Na^+ (meq/L)	8.8	$CaCO_3$ (%)	0.6
Ca^{+2} (meq/L)	2.7	SAR	6.04
Mg^{+2} (meq/L)	13.2	OM (%)	0.4
K^+ (meq/L)	0.1	Available N (mg/kg)	21.8
CO_3^{-2} (meq/L)	N.D.	Available P (mg/kg)	9.10
HCO_3^- (meq/L)	5.5	Available K (mg/kg)	55.5
Soil physical properties			
Bd (Mg/m^3)	1.58	FC (%)	18.0
Ks (m/day)	2.70	PWP (%)	9.00
SP (%)	40.0	AWC (%)	9.00
Particle size distribution (%)			
Sand	90.8	Clay	6.0
Silt	3.20	Texture	Sandy

N.D.: Means not detected; EC: Soil salinity as electrical conductivity in soil paste extract; pH: soil reaction (1:2.5 soil water suspension); Bd: Soil bulk density; Ks: Saturated hydraulic conductivity; FC: Soil field capacity; PWP: Soil permanent wilting point; AWC: Soil available water content

Climatic conditions

Average monthly climatic data (maximum temperature, minimum temperature, solar radiation and rainfall) through the canola growing season from sowing to maturity were obtained from the closet automated weather station, belongs to the Central Laboratory of Agricultural Climate (CLAC), (Table 2). The data represent an average value of two growing seasons.

Table 2. Monthly climatic data through the canola growing season 2016/2017 and 2017/2018 (averaged of both seasons).

Months	SRAD (MJ/m^2/day)	T max (°C)	T min (°C)	Rainfall (mm)
October	15.4	28.3	19.9	0.5
November	11.6	24.5	16.8	1.3
December	9.8	21.1	13.3	0.3
January	11.4	19.0	10.6	0.7
February	13.1	19.0	10.9	1.3
March	17.4	23.0	13.3	1.3

SRAD: Solar radiation; T max: Maximum temperature; T min: Minimum temperature

Experimental practices and design

The experimental design representing four treatments was arranged in a randomized complete block design with three replicates per treatment. Each individual plot size was 5 m × 7 m= 35 m^2. The experimental treatments were: control (without soil conditioner application); soil treated with SBFL, added to soil before cultivation at rate of 10 t/ha; V, added to soil in irrigation water along the period of planting growing at rate of 5 ml/L (The required amount of vinasse was calculated for each irrigation event based on calculated applied water and laid in plastic barrels perforated from bottom and placed on the downstream direction of cutthroat flume); and a compost of rice and cotton straw mixed with V (CMV) at a 1:1 ratio [(compost: Vinasse)(w/w)], based on the rate of compost which was 0.5 % (5 ton per fed.). Analysis of soil conditioners are listed in Table 3 for SBFL, V and compost. The grains of canola were sown at rate of 3 kg per fed on 15th October in both growing seasons and harvested after 6 months on 10th April in both seasons. The preceding crop was maize and sunflower in the first and second seasons, respectively. Phosphorus fertilizer was applied with soil tillage at the rate of 100 kg P_2O_5 per hectare in the form of super phosphate (15.5 % P_2O_5). Potassium fertilizer was applied as one dose directly before the first irrigation at the rate of 60 kg K_2O per hectare in the form of potassium sulphate (48% K_2O). Nitrogen fertilizer was applied directly before the first and second irrigations at two equal doses with a rate of 110 kg N / ha in the form of urea 46.5 % N.

Canola plants were irrigated when soil moisture reached 50 % depletion from soil available water (Israelson and Hansen, 1962),by cutthroat flume (20 × 90 cm) according to (Early, 1975), using the following equations:

For the free flow:

$$Q = C \times (Ha)^n \ldots\ldots (1)$$

Where: Q=Discharge in (m^3/sec), C= Flow discharge coefficient (0.74), n= constant (1.84), H_a= water head at upper stream gauge.

For the submerged flow:

$$Q = C\,(H_a - H_b)^n / - (\text{Log}_{10} S) \ldots\ldots (2)$$

Where: C= 0.413; H_b =Water head at downstream gauge; n=1.482; S = Actual submergence fraction (H_b/H_a).

The flow is free if (H_b/H_a) = <65%; and if (H_b/H_a) = >65% the flow is submergence

The main source of irrigation water is blended water by fresh and drainage water from Tera branch canal (EC = 1.3- 1.6 dS/m).

Measurements

Soil measurements

Before sowing and after crop harvest, soil chemical analysis had been done using the classical methods described by (Cottenie *et al.,* 1982, Burt.R., 2004). Meanwhile, undisturbed soil samples were used for soil physical properties according to (Garcia, 1978, Klute, 1986). Soil field capacity (FC) and permanent wilting point (PWP) were measured by pressure membrane apparatus at pressures of 0.1 and 15 bars, respectively. Soil saturated hydraulic conductivity was determined using constant head well permeameter method employing Guelph permeameter apparatus (Reynolds and Elrick, 1985) using the following equation.

$$Kfs = (0.0041)(X)(R2) - (0.0054)(X)(R1) \ldots\ldots (3)$$

Where

Kfs: soil saturated hydraulic conductivity in the field (cm/sec);

R1: the rate of water level change in the first well with depth (H1) set at 5 cm, converted to cm/sec; R2:the rate of water level change in the second well with depth (H2)set at 10 cm, converted to cm/sec; X: the reservoir constant used when the combination reservoir used in sandy soil ~35.39 cm^2.

Particle size distribution of soil samples was determined by the international pipette method as described by Tan (1996). Soil bulk density was determined using cylindrical sharp edged core sampler method described by (Culley, 1993). Soil organic carbon was determined according the wet combustion of modified (Walkley and Black, 1934). Soil available N, P and K were extracted and determined using methods reported by (Keeney and Nelson, 1982, Olsen and Sommers, 1982, Simard, 1993).

Plant measurements

At canola maturity, the middle row was harvested randomly from each plot to estimate: 1- plant height (cm) by measuring the distance between soil surface and the top of main stem; 2- seed yield (kg/ha) through calculating the weighting of two ridges following air dried, then seeds at 15 % moisture were weighted and converted to kg/ha; 3- oil content (%) was determined according to (AOAC., 2007); 4- protein content (%) was calculated by multiplying the total nitrogen in canola grains by 5.75. The total nitrogen in canola grains determined by Kjeldahl Method (AOAC., 2007) .

Table 3. The soil conditioner properties

Compost		Vinasse*		SBFL*	
Item	**Value**	**Item**	**Value**	**Item**	**Value**
Density (g cm^{-3})	0.65	pH	4.4	Al (g kg^{-1})	1.7
Moisture content (%)	25.5	EC (dS/m)	15.5	Fe (g kg^{-1})	0.85
pH (1:10 compost: water suspension)	7.16	Density (g cm^{-3})	1.2	Mn (g kg^{-1})	0.08
EC (1:10 w/v compost/ water suspension)	4.23	Organic matter (%)	6.2	S (g kg^{-1})	20.3
Saturation percentage % (g/100g)	175.0	Fluvic acid (%)	0.85	N (g kg^{-1})	3.2
CEC (cmole kg^{-1})	64.34	Humic acid (%)	0.35	P (g kg^{-1})	5.0
Total organic – c %	25.5	Total N (mg/L)	1205.0	K (g kg^{-1})	2.0
Total organic matter %	43.96	NH^{+}_{4} (mg/L)	88.0	EC (dS/m)	8.5
C/N ratio	21.98	NO^{-}_{3} (mg/L)	180.0	$CaCO_3$ (%)	23.1
Available – N (mg kg^{-1})	100	Total P (mg/L)	425.0	pH	8.80
Available – P (mg kg^{-1})	50.0	Soluble P (mg/L)	184.0	OM (%)	2.9
Available – K (mg kg^{-1})	85.0	Total K (%)	0.62	Density (g cm^{-3})	1.1
Available – Fe (mg kg^{-1})	450	Total Ca (%)	0.55		
Available – Mn (mg kg^{-1})	100	Total Mg (%)	0.27		
Available – Zn (mg kg^{-1})	35	Total Na (%)	0.06		
Available – Cu (mg kg^{-1})	135	SO_4 (%)	0.65		
Total N (%)	1.16	Total solids (g/L)	88.0		

***Analysis of Vinasse and SBFL was provided from Sugar Factory Company; Ec: electrical conductivity (dS/m).**

Water productivity (WP)

WP was calculated according to the following equation according to Davis *et al.*,2017.

$$WP\ (\frac{kg}{m3}) = \frac{Y}{Wa} \ldots\ldots\ldots\ldots\ldots(4)$$

Where Y: is the grain yield (kg) and Wa: water applied

Economic evaluation

Cash inflows and outflows for various treatments (at prices of the local market) were calculated, and some economic indicators were estimated as follows (Atiea, 1986):

1- Net return: It can be calculated by deducting the total cost from the total return, (LE/fed.)
2- Benefit-cost ratio, BCR: It can be calculated by dividing the total seasonal return on the total seasonal cost, (Atiea, 1986).
3- Specific cost (LE/kg): It can be calculated using the following formula:

$$S.C. = \frac{\text{Total costs}, \frac{LE}{fed}}{\text{Theoretical grain yield}, \frac{kg}{fed}} \ldots\ldots\ldots\ldots(5)$$

4- Theoretical grain yield: It was calculated using the following equation (Beshara, 2012):

$$\text{Theo. grain yield} = \left\{\frac{\text{straw yield}, \frac{ton}{fed} \times \text{price}, \frac{LE}{ton}}{\text{price per ton of grain}}\right\} + \text{main grain yield, ton} \ldots\ldots(6)$$

Statistical analysis

The obtained data were subjected to analysis of variance (ANOVA) procedure according to Gomez and Gomez (1984), using the MSTAT-C statistical software package. Means were compared using Duncan's multiple range test (Duncan, 1955), when the ANOVA showed significant differences ($P < 0.05$).

RESULTS AND DISCUSSION

Soil chemical properties

Soil salinity and sodicity

Soil salinity expressed in EC values (dS/m) increased under the effect of the studied amendment applications. The increase percentages were 26.92, 12.31 and 21.54 % for V, SBFL and CMV respectively relative to control (Table 4).

This is may be attributed to the relatively high concentrations of dissolved salts in such amendments Table (3). The prevailing of monovalent cations, particularly sodium in these amendments is responsible for increasing EC values in soils treated with vinasse (Paz *et al.*, 2009). The same trend was noticed with soil adsorption ratio (SAR). The SAR values increased by 9.33, 3.66 and 7.66 % due to application of V, SBFL and CMV respectively (Table 4).

Interestingly, application of compost mixed with vinasse decreased soil salinity and sodicity by 4.24 % and 17.89 % respectively compared to soil treated with vinasse only, confirming the importance of compost to alleviate higher salinity and sodicity in vinasse. This is likely due to high organic matter inputs which occupied cation-exchange sites and coated soil particle surfaces, limiting Na adsorption and enhancing leaching of Na and salts by precipitation (Wright *et al.*, 2008). Furthermore, high concentrations of basic cations in composts may affect the potential of composts to alter ex- tractable Na and salinity levels.

Soil pH

Soil pH values decreased with vinasse application and the lowest values were obtained under combination of compost mixed with vinasse (Table 4). This is mainly due to the acidic effect of vinasse (Table 3), oxidation of organic matter and prevailing the free hydrogen ions (Jiang *et al.*, 2012). Meanwhile, SBFL slightly increased soil pH due to its higher content of calcium carbonate (Table 3). The treatment of CMV had a favorable effect on soil pH where, pH values decreased compared with the control treatment.

Table 4. Soil chemical characteristics subjected to application of vinasse, SBFL and compost mixed with vinasse (averaged of two seasons).

Treatments	Depth (cm)	EC (dS/m)	SAR	pH	Cations (meq/L)				Anions (meq/L)			
					Na^+	Ca^{++}	Mg^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	SO_4^{-2}
	0-20	1.25	5.92	7.9	8.5	2.6	1.5	0.1	0.0	5.5	6.0	1.3
Control	20-40	1.29	6.01	8.0	8.8	2.7	1.5	0.1	0.0	5.0	6.1	2.0
	40-60	1.35	6.15	8.1	9.2	2.8	1.6	0.1	0.0	5.5	6.4	1.8
Weighted mean		1.30	6.00	8.0	8.8	2.7	1.5	0.1	0.0	5.3	6.2	1.7
	0-20	1.40	6.05	7.5	9.2	2.9	1.7	0.1	0.0	6.4	5.5	2.0
Vinasse	20-40	1.75	6.77	7.2	11.5	3.7	2.1	0.2	0.0	5.0	8.1	4.4
	40-60	1.79	6.87	7.0	11.8	3.8	2.1	0.2	0.0	8.3	5.5	4.1
Weighted mean		1.65	6.56	7.2	10.8	3.5	1.9	0.2	0.0	6.6	6.4	3.5
	0-20	1.30	5.87	8.2	8.6	2.7	1.6	0.1	0.0	6.0	5.5	1.5
SBFL	20-40	1.42	6.14	8.2	9.4	3.0	1.7	0.1	0.0	6.5	5.0	2.6
	40-60	1.66	6.65	8.3	11.0	3.5	2.0	0.2	0.0	5.5	7.7	3.4
Weighted mean		1.46	6.22	8.2	9.6	3.0	1.8	0.1	0.0	6.0	6.0	2.5
	0-20	1.40	6.05	7.0	9.2	2.9	1.7	0.1	0.0	6.4	5.5	2.0
CMV	20-40	1.65	6.61	7.1	10.9	3.5	2.0	0.2	0.0	5.0	7.6	3.9
	40-60	1.71	6.73	6.9	11.3	3.6	2.1	0.1	0.0	7.9	5.5	3.7
Weighted mean		1.58	6.46	7.0	10.5	3.3	1.9	0.1	0.0	6.4	6.2	3.2

EC: Electrical conductivity; SAR: Sodium Adsorption Ratio

Soil organic matter (OM)

Soil organic matter increased by 25.0, 20.0, and 42.5 % due to adding V, SBFL and CMV respectively compared with control, (Fig. 1A). This is mainly due to the relatively high content of organic matter in such conditioners, particularly in V and CMV (Table 3). The highest values of OM were observed in soils treated with CMV. The low content of organic matter in vinasse compared to compost (Table 3), is mainly attributed to higher content of humic substances in vinasse. These substances characterize by their resistance to microbial attack due to its aromatic cores and the reaction of the soil humic substances with mineral surfaces, which reduces microbial degradability compared to compost with higher degradability (Gerke, 2018; Biswas *et al.*, 2009).

Soil available macronutrients

Data in (Fig. 1B, C and D) indicated that application of V, SBFL and CMV increased soil available N, P and K compared to the control. The highest values of soil available N and K were observed under application of V and CMV.

Meanwhile, soil available P was superior under application of SBFL (Fig. 1C). This is mainly attributed to their initial content of these elements (Tables 3), where V and CMV are richly in N and K than P, but SBFL is richly in P than N and K, confirming the importance of using such amendments in providing the macronutrients to sandy soils.

Soil physical properties

Bulk density

Application of CMV, vinasse and SBFL decreased soil bulk density compared with control (Fig. 1E). The lowest values of soil bulk density were recorded under CMV and V compared with SBFL and control. This could be attributed to that vinasse includes high content of Na^+, which can cause dispersion of clay particles, blocking soil macro pores, and increasing soil volume (Morgan-Salazar *et al.*, 2016). Moreover, vinasse and compost have higher content of organic matter than SBFL, forming organo-mineral complexes and increasing the soil volume by aggregating soil mineral particles. Also, it may be due to the decomposition of added organic matter, forming exudates that are responsible for increasing soil aggregates (Six *et al.*,2004).

Saturated hydraulic conductivity and Soil available water

Soil hydraulic conductivity values decreased in response to conditioners application compared with control (Fig. 1F), favoring soil water conservation and increasing soil available water capacity. Prevailing of organic matter and monovalent cations in further amendments is the main reason for decreasing soil hydraulic conductivity. The highest value of soil available water (9.7 %) was recorded in case of CMV application, achieving an increase of 8.9 % relative to control. This is mainly due to increasing soil organic matter content and improving soil aggregation stability, promoting higher water retention in soils amended with compost and vinasse (Głąb *et al.*, 2018). The effect of SBFL on soil available water content (AWC) was slightly lower than vinasse and CMV due to its lower content of organic matter and monovalent cations than V and CMV. However, AWC in soils amended with SBFL was higher than untreated soils (control),(Fig. 1G) ,due to its finer texture and its higher specific surface area that promoting soil water holding capacity in sandy soils (Seleiman and Kheir, 2018b).

Water applied and water productivity

Due to the improving of sandy soil properties in response to application of V, SBFL and CMV, applied water quantities showed a reduction from 1025.3 m^3/fed in the unamended soils (control) to 947, 943.3 and 846.3 m^3/fed in soils amended with V, SBFL and CMV respectively (Fig. 2). This will save water by about 78.3, 82.0 and 179.0 m^3/fed under V, SBFL and CMV application respectively. Consequently, canola water productivity increased compared with control (Fig. 2). The highest value of water productivity 3.4 kg/m^3 was noticed in case of CMV application followed by V and SBFL. This is mainly attributed to the substantial role of organic matter in CMV for improving soil chemical, physical and nutritional properties, ensuring high crops with less drops.

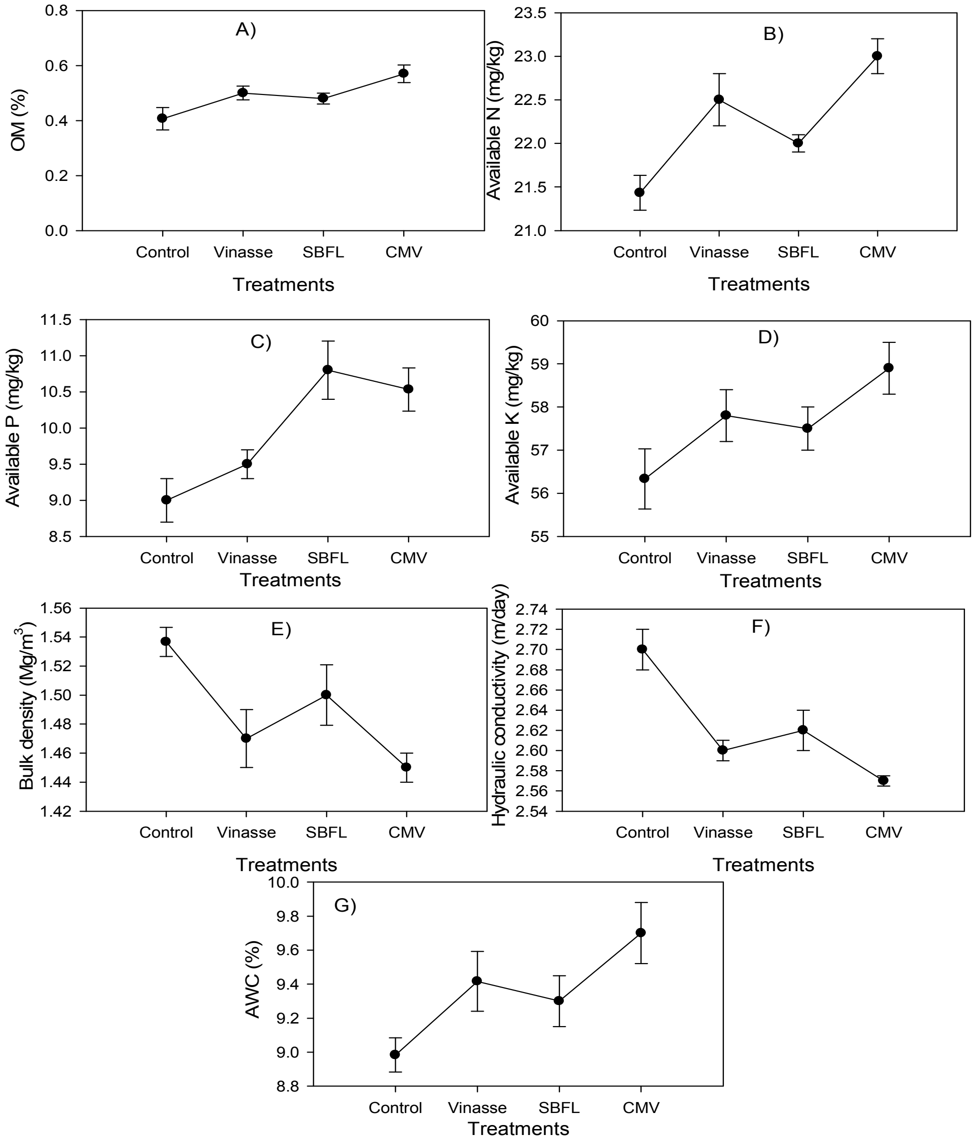

Fig. 1. Soil organic matter (A), available N (B), available P (C), available K (D), bulk density (E), hydraulic conductivity (F) and available water content (G) subjected to different soil conditioners. Error bars represent standard deviations among replicates.

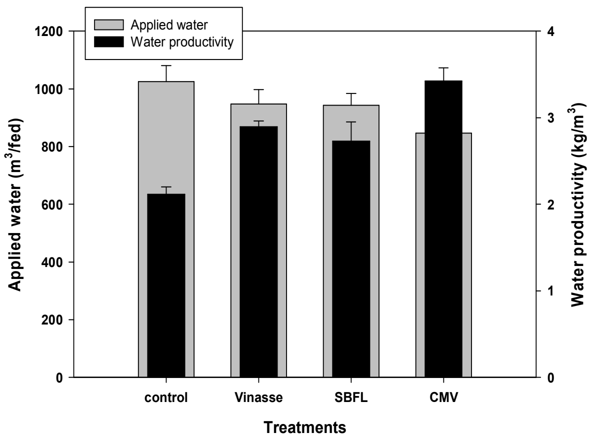

Fig. 2. Applied irrigation water and water productivity in sandy soil under different soil conditioners application.

Canola plant growth and seed yield and quality

Data presented in Table 5 indicated that plant height (cm), seed yield (t ha^{-1}), straw yield (t ha^{-1}) oil content (%) and protein content (%) were significantly affected by the tested soil conditioner treatments in both seasons**.** Application of the soil amendments (V, SBFL and CMV) significantly increased plant height in the two seasons as compared to control (without soil amendments). The CMV treatment gave the highest mean value of plant height without significant differences with those obtained by the V treatment in the two seasons. This may be due to the double effect of vinasse and compost together in the treatment of CMV.

The highest seed yield (t ha^{-1}) was obtained from the soil treated with (CMV), followed by (V) and SBLF, while the lowest yield was obtained from untreated soil in both seasons. It would be noted that the seed yield increased by 28.6, 18.71 and 47.6 % in the first season, and by 40.0, 30.0 and 49.0 % in the second season due to the addition of V, SBFL and CMV, respectively compared with control. This increase in seed yield upon the addition of the tested soil conditioners could be attributed to its significant role in improving the available nutrient in the soil and the water holding capacity. It worth to mention that, the increase of the soil salinity induced from the conditioner's application did not affect the crop yield. This is due to the low retention capacity of sandy soils, and to the high tolerance of canola plants to salinity (Tahmasebpour *et al.*, 2018). The highest seed yield resulted from CMV treatment relative to other amendments could be attributed to the double effect of compost and vinasse in ameliorating soil properties. The improvement of seed yield of canola plants treated with CMV in this investigation could be due to the initial analysis of CMV and its significant role in improving soil chemical, physical, fertility and water holding capacity. These results are in harmony with those obtained by (Seddik *et al.*, 2016, Madejón *et al.*, 1995).

Regarding oil content (%), data presented in Table 5 showed that, the application of CMV had the highest value (42.5%) without significant differences with those obtained by the V treatment (41.8%) in the first season. However, in the second season the application of SBFL recorded the highest value of oil content (42.1%) without significant differences with those recorded by the CMV or V treatments. Similarly, the application of V, SBFL and CMV led to significant increase in protein content compared to the control in both seasons. However, there were no significant differences among V, SBFL and CMV in protein content in both seasons. These results may be attributed to the high content of nitrogen and potassium in these conditioners, which are responsible for many biochemical processes such as photosynthesis, respiration, protein and carbohydrates metabolism (Awaad *et al.*, 2010). These findings suggest that the use of soil conditioners can be considered an effective tool in increasing canola seed yield in sandy soil.

Table 5. Effect of some soil amendments on plant height, seed yield, oil and protein contents of canola in sandy soil during 2016/2017 and 2017/2018 seasons.

Treatments	Plant height (cm)		Seed yield (t ha^{-1})		Straw yield (t ha^{-1})		Oil content (%)		Protein content (%)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Control	124.8c	126.5c	٢.١٦٥.٠d	2.053.1c	12.1c	12.0d	40.0c	39.6b	22.3b	22.4b
Vinasse	129.3a	133.5a	٢.٧٤٠.٠b	2.833.3a	12.8a	12.7b	41.8a	42.0a	23.5ab	24.0a
SBFL	127.1b	130.2b	٢.٥٧٠.٠c	2.619.6b	12.6b	12.5c	41.1b	42.1a	24.4a	24.1a
CMV	136.3a	140.5a	3.145.4a	3.090.4a	13.1a	13.5a	42.5a	42.0a	24.5a	24.0a
F test	**	**	**	**	**	**	**	**	*	**

S1: First growing season; S2: Second growing season

Economic evaluation analysis

Economic assessment requires some items through which the evaluation process can be conducted. Tables 6 and 7 show the production cost values of the various components involved in the evaluation process.

Table 6. Agricultural operation costs and labor wages for canola in 2016/2017 and 2017/2018 seasons

Item		Costs according to the local market prices, LE.
Chemical fertilizers	N, as Urea, 45 kg N/fed was applied = 100 kg/fed	6000 LE/ton
	P, as calcium superphosphate, 15.5 % P_2O_5 (300 kg/fed)	2000 LE/ton
	K, as potassium sulphate, 48 % K_2O (50 kg/fed)	8500 LE/ton
Seed, (5 kg/fed)		10 LE/kg
Machinery costs	Tillage and planter	700 LE/fed
	Irrigation	500 LE/fed
	Harvest	400 LE/fed
Conditioner prices	SBFL	300 LE/ton
	V	350 LE/ton
	CMV	850 LE/ton
Labour wages	Fertilizer broadcast	200 LE/fed
	Irrigation+manual weed control	500 LE/fed
	Conditioner application	200 LE/fed
	Harvest	700 LE/fed
Land rent for winter season		4000 LE/fed
Grain yield (ton)		10000 LE/ton
Straw yield (ton)		2000 LE/ton

In order not to overlook one of the components of income from the canola crop (grain+straw) during the process of its economic evaluation, it has been converted the cash flow of the straw yield to what equivalent in terms of weight of grains. Then, adding this assumed weight to the actual grain yield, to give what so-called the theoretical grain yield Table (8). The latter is used in calculation of some economic indicators that contribute to the economic evaluation. From the data tabulated in Table 9, values of the total seasonal return ranged in descending order from CMV application 16317.5 LE/fed to 14512.5, 14039 and 11760 LE/fed for SBFL, V and control respectively in first growing season. The same trend was observed also in second growing season. This is mainly attributed to increasing the theoretical grain yield under CMV application compared with other treatments.

Table 7. Values of production cost components for different treatments in EGP* during two growing seasons

Cost items		Cost value, LE			
		Control	SBFL	V	CMV
N, Urea		600	600	600	600
K, K_2O		425	425	425	425
P, P_2O_5		600	600	600	600
Seed		50	50	50	50
Land rent for winter season		4000	4000	4000	4000
Machinery costs	Tillage and planter	700	700	700	700
	Irrigation	500	500	500	500
	Harvest	400	400	400	400
Labor wages	Fertilizer broadcast	200	200	200	200
	Irrigation + manual weed control	500	500	500	500
	Conditioner application	-	200	200	200
	Harvest	700	700	700	700
Conditioner prices		-	1290	1960	4250
Total cost		7975	9465	10135	12425

***EGP: Egyptian pound (LE).**

On the other hand, the values of net seasonal revenue showed an opposite trend. Where SBFL showed the higher values of seasonal net return in both seasons followed by V and CMV respectively compared with control (Table 9). This trend may be attributed to the higher production cost of CMV and V than that of SBFL with low production cost (Table 7). Consequently, the values of BCR increased with SBFL application recording the highest values followed by V, control and CMV respectively. Also, the specific cost value (LE/kg) was higher subjected to CMV application and lower under SBFL application, favoring the latter in enhancing canola productivity from the economic view point.

Table. 8 Canola grain yield and straw yield and theoretical grain yield under different treatments in two seasons

Treatments	Mean grain yield (ton/fed)	Mean straw yield (ton/fed)	Theoretical grain yield (ton/fed)
	2016/2017		
Control	0.91	5.26	1.176
SBFL	1.17	5.56	1.451
V	1.13	5.47	1.403
CMV	1.34	5.69	1.631
	2017/2018		
Control	1.00	4.80	1.100
SBFL	1.21	5.52	1.493
V	1.13	5.43	1.401
CMV	1.30	5.86	1.597

Table 9. Total return, cost, net return and some economic criteria for canola production under different conditioners application in two growing seasons

Treatments	(a) Theoretical grain yield (ton/fed)	(b) Total seasonal return (LE/fed)	(c) Total seasonal cost (LE/fed)	(b-c) Net return (LE/fed)	(b/c) Benefit cost ratio	(c/a) Specific cost (LE/kg)
		First growing season				
Control	1.176	11760.0	7975	3785.0	1.47	6781.5
SBFL	1.451	14512.5	9465	5047.5	1.53	6522.0
V	1.403	14039.0	10135	3904.0	1.39	7219.2
CMV	1.631	16317.5	12425	3892.5	1.31	7614.5
		Second growing season				
Control	1.100	11000.0	7975	3025.0	1.38	7250.0
SBFL	1.493	14930.5	9465	5465.5	1.58	6339.4
V	1.401	14017.0	10135	3882.0	1.38	7230.5
CMV	1.597	15974.5	12425	3549.5	1.29	7778.0

CONCLUSION

The results of the current study indicated that, the disposals of sugar beet factories which may cause problems to the environment, could be successfully used to improve sandy soil properties and crop productivity. This is very important as Egypt currently willing to reclaim wide agricultural area in low fertility and low water holding capacity desert soils. combining vinasse with compost gave the superiority in improving sandy soil properties and crop water productivity followed by V and SBFL compared with untreated soils (control). In addition, mixing vinasse with compost, alleviated the high salinity induced with vinasse and maximized their benefits to soil and plant. Economically, SBFL application achieved the superiority recording the higher values of seasonal net return, and BCR with lower specific cost followed by V and CMV respectively compared with control. The study recommends using CMV to improve the sandy soil properties and its productivity, despite its relatively low economic return compared to other conditioners, due to higher water productivity under CMV application compared to other conditioners. In addition, CMV decreased higher salinity of vinasse and increased soil organic matter, confirming its importance on long term application and supporting the sustainable agriculture in sandy soils. Nevertheless, further future research needed to be studied to explore the effect of different rates of these conditioners on soil properties and crop production even with other strategic crops (i.e. wheat and maize). Moreover, potential mixing of CMV with SBFL in different mixing rates (i.e. 1:1; 2:1; 2:2; 3:1; 3:2 and 3:3, w/w) could be studied also to maximize the benefit of these low-cost conditioners in improving sandy soil properties.

REFERENCES

Abdallah, M., Dubousset, L., Meuriot, F., Etienne, P., Avice, J. C. & Ourry, A. 2010. Effect of mineral sulphur availability on nitrogen and sulphur uptake and remobilization during the vegetative growth of Brassica napus L. *Journal of Experimental Botany,* 11**,** 3239–3253.

Aoac. 2007. Official Methods of Analysis. *18th Ed. Association of Official Analytical Chemists, Inc., Gaithersburg, MD, Method 04.,* http://www. eoma. aoac.org/.

Atiea, A. M. 1986. Economic of Farm Mechanization. *The Egyptian Public Authority for Book,* 1986.

Awaad, M. S., Azza, R. A. & Mohamedin, A. M. 2010. EFFECT OF DIFFERENT APPLIED OF POTASSIUM SOURCES ON QUANTITY AND QUALITY OF GROUNDNUT CROP GROWN UNDER NEWLY RECLAIMED SANDY SOIL CONDITIONS. *Fayoum J. Agric. Res. & Dev,* 24**,** 37-48.

Bishara, A.T. 2012. Effect of Soil Moisture Depletion and Nitrogen Fertilizer Application Date on Wheat Yields, Water and Fertilizer Use Efficiencies in North Africa. PhD Thesis.

Biswas, A. K., M. , Mohanty, K. M. & Misra, A. K. 2009. Distillery effluents effect on soil organic carbon and aggregate stability of a Vertisol in India. *Soil. Till. Res.,* 104**,** 241–246. http://dx.doi.org/ 10.1016/j.still.2009.02.012.

Burt.R. 2004. Soil Survey Laboratory Methods Manual. *USDAeNRCS,* Linoln, Nebraska.

Cetesb. 2006. Vinhaça: critérios e procedimentos para aplicação no solo agrícola. *Norma Técnica,* P4.231. São Paulo.

Cottenie, A., Verloo, P. M., Kiekens, L., Velghe, G. & Camerlynck, R. 1982. Chemical Analysis of Plant and Soils. *Lab. Anal. and Agrochem,,* State Univ., Gent, Belgium.

Culley, J. L. B. 1993. Density and compressibilty. In M.R.Carter (ed.): Soil Sampling and Methods of Analysis. *Canadian Society of Soil Science,* Lewis Publishers**,** Boca Raton, London.

Duncan, D.B. 1955. Multiple Range and Multiple F-tests. Biometrics, 1:1-42.

Davis, K.F., Rulli, M.C., Seveso, A., D'Odorico ,P. 2017. Increased food production and reduced water use through optimized crop distribution. Nature Geoscience, 10:919-924.

Early, A. C. 1975. Irrigation scheduling for wheat in Punjab. *Centosci Prog, Optimum Use of Water in Agriculture,* 3**,** 115-127.

Fao. 2018. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). *http://www.fao.org/nr/water/aquastat/countries_regions/EGY/, ,* accessed on [2018/11/23].

Garcia, C. 1978. Soil Water Engineering Laboratory Manual. *Department of Agricultural and Chemical Engineering,* Colorado State University, Fort Collins**,** Colorado, USA.

Gerke,J. 2018. Concepts and Misconceptions of Humic Substances as the Stable Part of Soil Organic Matter: A Review. Agronomy, 8, 76.

Głąb, T., Żabiński, A., Sadowska, U., Gondek, K., Kopeć, M., Mierzwa–hersztek, M. & Tabor, S. 2018. Effects of co-composted maize, sewage sludge, and biochar mixtures on hydrological and physical qualities of sandy soil. *Geoderma,* 315**,** 27-35.

Gomez, K.A., Gomez,A. 1984. Statistical procedure for agricultural research-hand book. New York, Wiley.

Hargreaves, J. C., Adl, M. S. & Warman, P. R. 2008. A review of the use of composted municipal solid waste in agriculture. *Agric.Ecosyst.Environ,* 123**,** 1-14.

Israelson, O. W. & Hansen, V. E. 1962. Irrigation Principles and Practices. *3 rd Ed,* John Willey& Sons**,** Inc., New York.

Jiang, Z. P., Li, Y. R., Wei, G. P., Liao, Q., Su, T. M. & Lu, C. Y. 2012. Effect of long-term vinasse application on physico-chemical properties of sugarcane field Soils. *Sugar Technol,* 14**,** 412-417.

Keeney, D. R. & Nelson, D. W. 1982. Nitrogen- Inorganic forms: Chemical and Microbiological Properties. *ASA, Inc. SSSA, Inc.,,* Publisher, Madison**,** Wisconson, USA.

Kheir, A. M. S., Bayoumi, M. A. & Abouelsoud, H. M. A. 2017. Effectiveness of natural soil conditioners and irrigation regime on:1- loamy sand soil properties, crops production and water productivity. *Menoufia J.Soil Sci.,* 2**,** 227-246.

Klute, A. 1986. Methods of Soil Analysis, Part 1 (2th Ed.): Physical and Mineralogical Methods. *ASA, Inc. SSSA, Inc., ,* Publisher, Madison, Wisconsin, USA.

Madejón, E., Díaz, M. J., López, R., Murillo, J. M. & Cabrera, F. 1995. CORN FERTlLIZATION WITH THREE (SUGARBEET) VINASSE COMPOSTS. *Fresenius EnvÍr Bull* 4**,** 232-237.

Malr. 2014. Bulletins of Agricultural Statistics No. 1 Arab Republic of Egypt, . *Ministry of Agriculture and Land Reclamation,,* the Egyptian Economic Affairs Sector, Dokki, Egypt.

Mavi, M. S., Sanderman, J., Chittleborough, D. J., Cox, J. W. & Marschner, P. 2012. Sorption of dissolved organic matter in salt-affected soils: effect of salinity, sodicity and texture. *Sci Total Environ,* 435**,** 337–344.

Morgan-salazar, R. G., Sanchez-lizarraga, A. L., Rodriguez-campos, J., Davila-vazquez, G., Marino-marmolejo, E. N., Dendooven, L. & Contreras-ramos, S. M. 2016. Utilization of vinasses as soil amendment: consequences and prodpectives. *Springer plus,* 5**,** 1007.

Olsen, S. L. & Sommers, L. E. 1982. Phosphorus. Methods of Soil Analysis, Part2: Chemical and Microbiological Properties. *ASA, Inc. SSSA, Inc.,,* Publisher, Madison, USA**,** 403-430.

Paz, C. B., Rub, J. A. M., Ginenez, R. G. & Ballesta, R. J. 2009. Impacts caused by the addition of wine vinasse on some chemical and mineralogical properties of a Luvisol and Vertisol in La Mancha. *Journal of Soils and Sediments,* 9**,** 121-128.

ReynoldS, W. D. & Elrick, D. E. 1985. In situ measurement of field-saturated hydraulic conductivity, sorptivity, and the alpha-parameters using the guelph permeameter. *Soil Sci,* 140**,** 292-302.

Seddik, W. M. A., Osman, M. A. & KenawY, M. H. M. 2016. Utilization of Vinasse and Feldspar as Alternative Sources of Potassium Fertilizers and Their Effect on Some Soil Properties and Crop Yield in Sandy Soils. *J. Soil Sci. and Agric. Eng., Mansoura Univ,* 7**,** 669-675.

Seleiman, M. F. & Kheir, A. M. S. 2018a. Maize productivity, heavy metals uptake and their availability in contaminated clay and sandy alkaline soils as affected by inorganic and organic amendments. *Chmosphere,* 204**,** 514-522.

Seleiman, M. F. & Kheir, A. M. S. 2018b. Saline soil properties, quality and productivity of wheat grown with bagasse ash and thiourea in different climatic zones. *Chemosphere,* 193**,** 538-546.

Shaheen, S. M. & Rinklebe, J. 2016. Sugar beet factory lime affects the mobilization of Cd, Co, Cr, Cu, Mo, Ni, Pb, and Zn under dynamic redox conditions in a contaminated floodplain soil. *J. Environ. Manag.,* 186**,** 253-260.

Simard, R. R. 1993. Ammonium acetate extractable elements: Soil Sampling and Methods of Analysis. *Canadian Society of Soil Science,* Lewis Publishers, Boca Raton, London.**,** 39-42.

Sims, A. L., Windels, C. E. & Bradley, C. A. 2010. Content and potential availability of selected nutrients in field applied sugar beet factory lime. *Commun. Soil Sci.Plant Anal. ,* 41**,** 438-453.

Six, J., Bossuyt,H., Degryz,S., Denef, K. 2004. A history of research on the link between (micro) aggregates, soil biota and soil organic matter dynamics. Soil Till. Res., 79: 7-31.

Tahmasebpour, B., NojADEH, M. S. & Esmaeilpour, M. 2018. Salt Stress Tolerance of Spring Canola (Brassica napus L.) Cultivars *International Journal of Plant Biology & Research,* 6**,** 1098.

Tan, K. H. 1996. Principles of soil chemistry, (2nd Ed.). Page 62. Marcel Dekker Inc., New York.

Walkley, A. & Black, A. 1934. An examination of the degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science,* 37**,** 29-38.

Wright, A.L., Provin, T.L., Hons, F.M., Zuberer, D.A., White, R.H. 2008. Compost Impacts on Sodicity and Salinity In a Sandy Loam Turf Grass Soil, Compost Science & Utilization, 16:1, 30-35, DOI:10.1080/1065657X.2008.10702352.

تأثير اضافه جير مصنع بنجر السكر والفيناس والكمبوست المختلط بالفيناس علي خواص الاراضي الرمليه وانتاجيه الكانولا

احمد محمد سعد خير[١] و محمد محمد قمره[٢]

[١] معهد بحوث الاراضي والمياه والبيئه ، مركز البحوث الزراعيه، الجيزه، مصر

[٢] قسم المحاصيل، كليه الزراعه، جامعه كفرالشيخ، كفرالشيخ، مصر

من المعروف ان مصر تشتهر بصناعه السكر سواء من البنجر نظرا لزياده رقعه الاراضي المتأثره بالاملاح وزياده مساحه بنجر السكراو من القصب في جنوب مصر، الامر الذي يؤدي لتكوين كميات كبيره من المخلفات الناتجه عن عمليه التصنيع. هذه المخلفات قد تكون ضاره بالبيئه اذا لم يعاد استخدامها والاستفاده منها مره اخري. من جهه اخري، فان الاراضي الرمليه والمستصلحه حديثا وكذلك المراد استصلاحها هي اراضي تعاني من قله الاحتفاظ بالماء وانخفاض خصوبتها بسبب قله الماده العضويه بها وبالتالي انخفاض انتاجيتها المحصوليه. كل ذلك يتطلب دراسات وابحاث لمعرفه امكانيه استخدام محسنات ارضيه جديده وذات تكلفه منخفضه. ومن هنا جاءت فكره استخدام مخلفات مصانع السكر في استصلاح الاراضي الرمليه وتحسين انتاجيتها لما تحتويه هذه المخلفات من عناصر غذائيه وغناها بالماده العضويه. لهذه الاسباب تم عمل تجربه حقليه في موسميين زراعيين (٢٠١٦/٢٠١٧ ، ٢٠١٧/٢٠١٨) في ارض رمليه بمركز بلطيم – محافظه كفرالشيخ ، وذلك لدراسه تأثير اضافه الجير الناتج من تصنيع بنجر السكر، الفيناس الناتج من عمليه تخمر الكحول اثناء عمليه تصنيع السكر، وكذلك خلط الفيناس مع الكبوست الناتج من مخلفات قش الارز والقطن بنسبه١: ١ (وزن/وزن) علي الخواص الفيزيائيه والكيميائيه والغذائيه للاراضي الرمليه وكذلك علي انتاجيه محصول الكانولا ومحتواه من الزيت والبروتين. وهو من المحاصيل الزيتيه الهامه والتي تولي الدوله المصريه حاليا اهتماما كبيرا بزياده المساحه المنزرعه منه لتقليل الفجوه الكبيره بين الاستهلاك وانتاج الزيوت .واوضحت اهم النتائج ان اضافه الكمبوست المختلط بالفيناس ادي لزياده محتوي التربه من الماده العضويه وزياده مغذيات التربه من العناصر الغائيه الكبري (نيتروجين، فوسفور وبوتاسيوم) وكذلك زياده قدره الارض علي الاحتفاظ بالماء وكانت زياده معنويه يليه اضافه الفيناس ثم اضافه الجير الناتج من تصنيع البنجر. ومن جهه اخري، ادت اضافه هذه المحسنات الي خفض قيم الكثافه الظاهريه والتوصيل الهيدروليكي. وهذا يدل علي امكانيه استخدام هذه المحسنات في تحسين خواص الاراضي الرمليه لضمان تحقيق الزراعه المستدامه. ونتيجه لتحسين خواص الاراضي الرمليه باضافه هذه المحسنات فقد زادت انتاجيه الكانولا (بذور) وكذلك ارتفع محتوي هذه البذور من البروتين والزيت. ومن وجهه النظر المائيه، فان اعلي قيم لانتاجيه وحده المياه قد تحققت باضافه الكمبوست المختلط بالفيناس يليه الفيناس ثم الجيرمقارنه بالكنترول (عدم اضافه محسنات) مما يؤكد اهميه هذه المحسنات في تحقيق اعلي انتاج محصولي بأقل كميه مياه مستخدمه في الاراضي الرمليه. واقتصاديا كانت الافضليه لاضافه مخلفات جير مصنع السكر حيث حقق اضافته اعلي صافي عائد واقل تكلفه انتاج بالمقارنه ب الفيناس ومخلوط الفيناس مع الكبوست. وعلي الرغم من ذلك فان الدراسه توصي باستخدام الكمبوست المختلط بالفيناس نظرا لعده عوامل اهمها ارتفاع انتاجيه وحده المياه في حاله اضافه الكمبوست مختلط مع الفيناس، تقليل الملوحه الناتجه عن الفيناس عند خلطه بالكمبوست بالاضافه ارتفاع الماده العضويه في الكبوست مما يؤكد اهميه هذا المحسن (كمبوست مختلط بالفيناس) في تحسين خواص الاراضي الرمليه والتنميه المستدامه بها.