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AGRONOMIC EVALUATION OF DILUTED VINASSE AS A SOURCE OF POTASSIUM FERTILIZERS FOR PEANUT AND CARROT CROPS

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ABSTRACT

A field experiment was carried out at El- Ismailia Agriculture Research Station Farm located at 30° 35´41.9" N Latitude and 32° 16´ 45.8" E longitude in Ismailia Governorate, Egypt. Peanut (*Arachis hypogaea*) was planted during summer season 2013 and carrot (*Daucus Carota*) was planted during winter season (2013-2014) on sandy soil under drip irrigation system in order to agronomic evaluate the use of diluted vinasse, a by-product from sugar industries, as a potassium fertilizer source to reduce the potassium mineral fertilizers and monitoring the movement of phenols through the soil profile layers.

Potassium mineral fertilizers were added with four rates , Zero, 50 ,75 and 100 % (K1,K2,K3 and K4) from the recommended dose , combined with five levels from the diluted vinasse 0, 5%, 10%, 15% and 20 % (C1, C2, C3, C4, C5), respectively.

Data revealed that the use of diluted vinasse along with applied K- mineral fertilizers rates show significant decrease in pH values by increasing the concentration of both vinasse and K- mineral fertilizers. O.M, availability of N, P and K along with total phenols values, generally were also generally increased by increasing the concentration of vinasse, in presence of different rates of potassium mineral fertilizers especially for the soil surface layers as compared to sub soil layer. Treatment of K (75 %) combined with C (20%) was superior for availability of N, P and K as compared to vinasse only and other treatments for both tested crops . Total uptake of N, P, K (kg fed^{-1} along with yield components of both tested crops increased gradually by increasing the concentration of vinasse from C1 to C5 and K from K1 up to K3, then the values slightly decreased with K4 as compared to the other treatments.

Interaction analysis revealed that N, P, K total uptake and total yield components for peanut (straw, seeds) and carrot (shoots, roots) recorded the highest values due to applying 75 % from the mineral K- fertilizers combined with diluted vinasse (20%) as compared to the control and other treatments; the lowest values of N, P and K uptake were recorded with control treatment (vinasse only).

Finally, the application of diluted vinasse to sandy soils has added significant amounts of nutrients especially K as well as organic matter which improved soil chemical properties, nutritional status and crop yield. So, 25% from the potassium mineral fertilizer required for either peanut or carrot can be reduced by the use of diluted vinasse (20%). Moreover the use of diluted vinasse is safty for environment which did not cause any bioaccumulation of phenol compounds in sandy soils and thus the phenolic components, as expected, not contaminating the sub soil layer and ground water.

Keywords: Potassium fertilizers - vinasse - total phenols- peanut - carrot- yield - nutritional status.

INTRODUCTION

Vinasse is a waste material from distillery industries which has potential to cause major enviro

nmental problem across the world (Renewable Fuels Association, 2011). The production of ethanol for fuel, pharmacy, industrial use and alcoholic beverages has increased in recent years worldwide; its production generates between 9 to 14 liters of waste water per liter of ethanol which are known as vinasse. The raw vinasse have recalcitrant compounds and characteristics like acid pH (3.5-5), high chemical oxygen demand (COD) ranging from 50 to 150 g/L. as well as dark brown colour.

Vinasse is used in crop fertigation indiscriminately; however, many previous studies showed that, this wastewater generates serious environmental damage as the reduction in crop yield or even its death in the short-term. Acidifications, decreased oxygenation, increased organic load, accumulation of phenols were recorded in soil in the long term. Also, Vinasse was reported to be potentially toxic because of its bio-recalcitrant substance contents, such as phenolic compounds and pigments like melanoidins, which may inhibit the activity of microorganisms present in water sources (Figaro et al., 2006). So, the presence of phenolic compounds deserves special attention because of their high toxicity. They are known as a kind of pollutants to be prioritized by USEPA (Subramanyam and Mishra, 2007). The hazard action may be due to use the concentrated vinasse which may led to a slight increase in the abundance of phenolic compounds, acid-insoluble fraction, and a slight decrease in the labile fraction of vinasses derived from sugar beet (Parnaudeau et al.,2007). Accordingly, in order to improve its chemical properties and use of vinasse it should be diluted to 50 or75 %.

On the other hand, recent study reported that vinasse is considered as a potential source of organic matter and plant nutrients with no toxic chemicals or residues, has no safety measures required by state, federal, or international regulations, and has no harmful effects on human health. There is no bioaccumulation of vinasse or its components as it easily decomposes by micro-organisms in either soil or water. Because of the high decomposition rate of the organic matter, the components of the material do not accumulate (BioBizz Worldwide, 2011). Moreover, safety information including MSDS & substance report from National Institute of Environmental Health Studies, showed no hazard substance for beet or sugar cane vinasse, or any industrial waste from the sugar industry. Filho et al., (1996) and Muhammad et al., (2012) found that continuous application of vinasse in sandy soils of sugarcane field could not cause ground water pollution. Vinasses have nutrients and compounds that can be used for the growth of crops, such as nitrogen, phosphorus and potassium, as well as a high organic matter content. In spite of that, Jiang et al., (2012) reported that raw vinasse application to soil , initially decreased soil pH with high content of free hydrogen ions; but at later stage of 30 or 45 days after the application increased to optimum level for organic matter oxidation (H^+ act as an electron acceptor). Later on, Prado et al., (2013) mentioned that, pollutant caused by discarding vinasse into the soil or running waters was an incentive to studies aiming to find alternative, economic applications for use of this residue. Arafat and Yassen (2002) previously concluded that vinasse is a good source of available P and K when applied to the soil and its application may reduce the amount of fertilizers required for optimum crop yield ; they suggested that vinasse could substitute for about 62% of P and 100% of K required for wheat yield.

Osman (2010) mentioned that application of vinasse to field crops is a viable method for its disposal. Furthermore, it had a direct effect as a good source replacement for nutrients, at least partially, for mineral fertilizers, and indirect effect through improving the nutrient uptake and wheat yield. Recently, Vadivel et al., (2014) concluded that vinasse application in agriculture has added significant amount of nutrients, improved the soil quality of degraded land and increased crop yields.

The objectives of the present study are based on the agronomic evaluation of peanut and carrot yields, as well as nutritional status for the two crops as a result of using diluted vinasse . It is considered as potassium fertilizer source, due to its high content of potassium, to replace the potassium mineral fertilizers. Also, monitoring the movement of phenols through the soil profile is also an object, to clear the picture about using this residue for agriculture without harming the environment.

MATERIALS AND METHODS

A field experiment was carried out using peanut (*Arachis hypogaea*) during summer season 2013 and carrot (*Daucus Carota*) during winter season (2013-2014) both crops cultivated on sandy soil at Ismaillia Agric. Res. Station, ARC, located at 30° 35´41.9" N Latitude and 32° 16´ 45.8" E longitude, under drip irrigation system . The work aimed to agronomic evaluation the use of diluted vinasse as a potassium fertilizer source for replacement potassium mineral fertilizers. The study included monitoring the movement of phenols through the soil profile. Some physical and chemical characteristics of the tested soil sample are shown in Table (1), vinasse composition being shown in Table (2)

Table (1): Some physical and chemical properties of the experimental soil

Soil characteristics	Values
Particle size distribution %	
Coarse Sand	62.2
Fine Sand	25.4
Silt	5.40
Clay	7.00
Texture class	Sandy
Chemical properties	
$CaCO_3$ %	1.40
pH soil- water (Suspension 1: 2.5)	7.92
EC dSm^{-1} (saturated paste extract)	0.38
Organic matter %	0.40
Soluble cations and anions (mmole l^1)	
Ca^{++}	0.95
Mg^{++}	0.89
Na^+	1.51
K^+	0.45
CO_3^{--}	-
HCO_3^-	1.42
Cl^-	1.02
SO_4^{--}	1.36
Available nutrients (mg kg^{-1})	
N	40
P	15
K	31

Table (2): Some physical and chemical characteristics of concentrated vinasse.

pH	EC dSm^{-1}	Total phenols (%)	Organic carbon (%)	Organic matter (%)	Density (gml^{-1})	Total nutrients (%) N	P	K
4.20	20.0	0.118	3.60	6.20	1.29	0.22	0.42	6.40

Concentrated vinasse is provided by integrated industries and sugar Co., El-Hawamdia, Egypt. Mineral fertilizers applied to control treatment from ammonium sulphate (20.5 %) Superphosphate (15.5 % P_2O_5) and

Potassium sulphate (48 % K_2O) were at rates of 100, 200 and 50 kg fed $^{-1}$ for peanut and 150, 200 and 50 kg fed $^{-1}$ for carrot, respectively. All treatments received recommended doses from N and P; potassium mineral fertilizers were added with four rates: Zero, 50, 75 and 100 % (K1, K2, K3 and K4) from the recommended dose combined with the five concentrations from the diluted vinasse: 0, 5, 10, 15 and 20 % (C1, C2, C3, C4, C5), respectively. All treatments were sprayed two weeks after planting, on surface soil with diluted vinasse once a week for eight weeks along the period of plant growth, volume of added spray solution being 10 L. for each plot where area was 40 $m^{2.}$ .Three plots were considered for one specified treatment.

The experiment was designed as a split plot design with three replicates. The main plots represented the mineral K-fertilizers; the sub-main plots stand for the different concentrations of diluted vinasse. With respect to mineral fertilizers, super phosphate was added before planting ; ammonium sulphate was applied in four equal split doses after 2 , 4 , 6 and 8 weeks from sowing .

Plants were harvested for both tested crops, at maturity, from each plot and the yield components (straw and seeds) for peanut, (shoot and root) for carrot were evaluated and subjected to oven drying at 70° C, up to a constant dry weight, ground and prepared for digestion using a mixture of H_2SO_4 and H_2O_2 as described by Page et al., (1982). Furthermore, three soil samples were taken from each treatment at three soil profile depths (D1, D2 and D3). The first soil sample was taken from 0-15cm depth, the second from 15-30 cm and the third from 30- 45 cm. Soil samples were taken, after harvesting stage, for chemical analysis to evaluate the values of soil pH, EC, availability of nutrients (N, P and K) which be determined according to Page et al., (1982). Total phenolic compounds were extracted with methanol using Soxhelt apparatus according to the method described by Santana et al., (2009) and determined with Ortho-Phenanthroline method according to Gonzalez et al., (2003). Obtained results were subjected to statistical analysis according to Snedecor and Cohran (1982); the treatments were compared using the least significant difference (L.S.D) at 0.05 level of probability.

RESULTS AND DISCUSSION

1-Effect of diluted vinasse on soil chemical characteristics and nutrient availability after harvesting peanut and carrot crops.

Data presented in Table (3, 4) show the responses of some soil chemical properties to the tested treatments of diluted vinasse as a source of potassium fertilizers.

Chemical properties of the studied soil:

1. Soil reaction (pH)

It is well known that the pH value is important for healthy plant growth and nutrients availability. Data presented in Tables (3, 4) indicated that application of diluted vinasse with mineral potassium fertilizers rates (Zero, 50, 75 and 100%) from the recommended dose, led to slightly decrease pH values gradually by increasing the concentration of vinasse and K- mineral fertilizers as compared to the control treatments ; this may be due to production of organic acids and hydrogen ion (H^+) from decomposition of vinasse in soils (El-Leboudi et al., 1988). This is true in spite of higher pH values with soil profile depth from D1 to D3 but generally still less than the values of control treatment.

2. Electrical conductivity (EC)

(EC) values generally increased by increasing the concentration of vinasse, due to relatively high contents of dissolved salts, in the vinasse, especially monovalent cations, particually Na^+ (Paz et al., 2009) . However, (EC) values decreased gradually with soil profile depth, similar result being recorded for both studied seasons.

3. Organic Matter (O.M)

Concerning the organic matter content in the soil after harvesting peanut and carrot crops, data presented in Tables (3, 4) indicate that organic matter contents increased with increasing the application of vinasse as compared to control treatment. Of course, this may be due to its relatively high content of O.M (Madejon et al., 2001). Such results are in agreement with those of Arafat and Yassen, (2002) who reported that the residual O.M in soil after harvesting increased with increasing the concentration of vinasse. This is true in spite of decreases with soil profile depth from D1 to D3, similar results being recorded for both tested seasons.

As a conclusion, applied materials depressed the values of pH in spite of higher values for the deep soil layer. Such materials were, however, favourable of both EC and organic matter content.

4. Nutrient availability in soil after harvesting of both peanut and carrot crops

The data representing the nutrients availability (N, P and K) in soil after peanut and carrot harvesting are shown in Tables (3, 4). Statistical interaction analysis showed that all applied treatments of potassium and vinasse were significantly favorable as compared to the control treatments (vinasse only); this trend was true for both tested crops.

Generally, the availability of nitrogen, phosphorus and potassium increased significantly with increasing the concentration of applied vinasse from C1 to C5 especially in presence of K2 (50%) and K3 (75%). However, it decreased gradually with soil profile depth; this may be due to presence of vinasse which increased plant nitrogen utilization and avoid the potential leaching losses during the growth stages. The same results were obtained by Delin and Engstrom, (2010). Moreover, presence of vinasse possibly produce of organic acids upon decomposition of vinasse in soil which reduced soil P-fixation and increased the available P by solubilization action (Mahimairaja and Bolan,2004). Also, vinasse application added a significant amount of nutrients and improved soil quality(Madejon et al, 2001) and (Vadivel et al., 2014) ;increases in potassium availability ,as expected, increased gradually by increasing the dose of K- fertilization, similar results being obtained by Paz et al. (2009).This is true in spite of decreases with soil profile depth.

Table (3): Effect of applied diluted vinasse and different rates of k fertilizer on soil chemical characteristics and nutrients availability for peanut crop.

Rate of K fertilizer	Conc. of vinasse	Depth (cm)	PH (1:2.5) (soil: water susp.)	E.C e (dSm^{-1})	O.M (%)	Available element (mg kg^{-1}) N	P	K
Control		D1	7.82	0.28	0.25	185	30.0	80.0
		D2	7.84	0.17	0.20	182	28.0	50.0
		D3	7.86	0.13	0.12	170	18.0	40.0
K1(without)	C1(without)	D1	7.61	0.21	0.25	196	34.0	52.2
		D2	7.64	0.15	0.14	182	32.2	49.7
		D3	7.70	0.08	0.10	168	20.5	39.0
	C2 (5%)	D1	7.51	0.23	0.39	199	38.0	54.8
		D2	7.54	0.14	0.25	189	24.6	41.9
		D3	7.58	0.13	0.12	168	25.8	28.3
	C3 (10%)	D1	7.39	0.25	0.40	196	42.5	60.7
		D2	7.48	0.13	0.33	182	24.3	39.0
		D3	7.65	0.12	0.13	180	20.9	28.3
	C4 (15%)	D1	7.38	0.26	0.41	175	45.5	62.3
		D2	7.40	0.17	0.27	185	32.4	57.5
		D3	7.45	0.13	0.14	196	20.4	41.0
	C5 (20%)	D1	7.31	0.56	0.50	200	47.0	66.1
		D2	7.51	0.17	0.31	210	37.9	56.6
		D3	7.68	0.10	0.13	213	20.0	36.1
K2(50%)	C1(without)	D1	7.63	0.10	0.32	231	36.3	64.4
		D2	7.65	0.08	0.18	189	21.9	36.1
		D3	7.65	0.07	0.12	182	19.6	27.3
	C2(5%)	D1	7.62	0.18	0.43	196	41.3	68.2
		D2	7.62	0.11	0.27	189	30.3	44.9
		D3	7.67	0.09	0.24	175	14.9	33.2
	C3 (10%)	D1	7.60	0.39	0.44	233	46.4	70.0
		D2	7.63	0.18	0.40	203	34.8	51.7
		D3	7.70	0.07	0.32	182	18.3	33.2
	C4 (15%)	D1	7.34	0.41	0.55	203	50.9	81.9
		D2	7.67	0.07	0.24	210	28.3	36.1
		D3	7.83	0.06	0.09	210	19.5	30.2
	C5 (20%)	D1	7.21	0.44	0.42	182	54.9	93.6
		D2	7.67	0.33	0.40	196	29.9	45.8
		D3	7.68	0.11	0.24	231	23.7	56.6
K3(75%)	C1(without)	D1	7.48	0.14	0.43	190	47.0	80.9
		D2	7.50	0.12	0.35	189	39.8	45.8
		D3	7.56	0.10	0.20	189	24.6	28.3
	C2 (5%)	D1	7.46	0.21	0.49	203	47.5	87.5
		D2	7.48	0.18	0.35	189	26.2	41.9
		D3	7.51	0.07	0.29	168	26.0	41.9
	C3 (10%)	D1	7.34	0.22	0.60	196	48.0	90.0
		D2	7.42	0.13	0.39	175	39.0	54.6
		D3	7.60	0.04	0.29	168	16.3	28.3
	C4 (15%)	D1	7.29	0.37	0.64	196	42.4	96.0
		D2	7.46	0.10	0.47	189	39.7	33.1
		D3	7.52	0.10	0.39	181	20.0	33.2
	C5(20%)	D1	7.27	0.42	0.65	238	45.5	99.0
		D2	7.53	0.16	0.43	231	36.8	36.1
		D3	7.54	0.15	0.35	191	27.4	36.1
K4 (100%)	C1(without)	D1	7.51	0.17	0.51	210	44.0	85.9
		D2	7.55	0.11	0.36	189	29.9	39.0
		D3	7.70	0.08	0.30	175	29.4	36.1
	C2 (5%)	D1	7.35	0.23	0.52	231	46.0	98.3
		D2	7.46	0.13	0.36	196	30.5	39.0
		D3	7.48	0.07	0.14	175	24.3	30.2
	C3 (10%)	D1	7.34	0.25	0.64	210	50.0	108.2
		D2	7.51	0.12	0.36	189	42.1	57.5
		D3	7.57	0.07	0.33	175	21.1	37.1
	C4 (15%)	D1	7.29	0.28	0.66	210	52.0	119.0
		D2	7.32	0.17	0.48	210	39.1	84.8
		D3	7.53	0.11	0.41	168	24.0	31.2
	C5 (20%)	D1	7.28	0.32	0.68	212	55.0	120.0
		D2	7.55	0.21	0.37	212	31.9	67.3
		D3	7.63	0.13	0.36	196	30.8	37.1
(A) rate of K fertilizers			0.020	0.002	0.020	0.33	0.90	0.42
(B) vinasse conc.			0.025	0.008	0.011	0.22	0.82	0.27
(C) depth			0.010	0.007	0.008	0.20	0.80	0.24
A*B			0.030	0.003	0.022	1.22	1.26	1.40
B*C			0.031	0.004	0.027	1.22	1.27	1.44
A*C			0.032	0.006	0.030	1.24	1.27	1.44
A*B*C			0.033	0.010	0.033	1.37	1.80	1.55

Table (4): Effect of applied diluted vinasse and different rates of k fertilizer on soil chemical characteristics and nutrients availability for carrot.

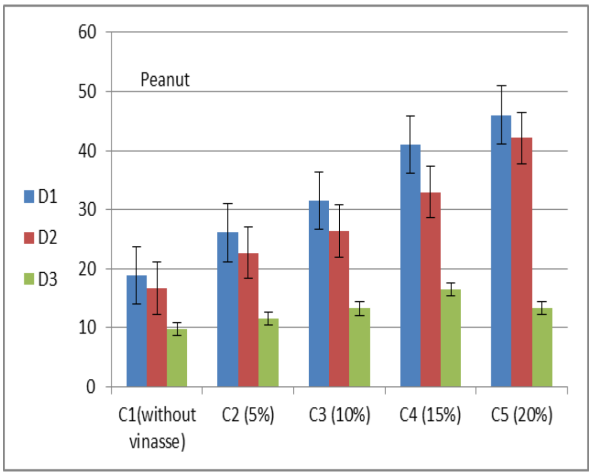
Rate of K fertilizer	Conc. of vinasse	Depth (cm)	PH (1:2.5) (soil: water susp.)	E.Ce (dSm^{-1})	O.M (%)	Available element ($mg\ kg^{-1}$) N	P	K
Control		D1	7.80	0.27	0.22	87.4	30.1	59.0
		D2	7.80	0.12	0.18	86.0	32.0	40.0
		D3	7.82	0.12	0.12	86.2	24.0	28.0
K1(without)	C1(without)	D1	7.82	0.20	0.23	92.0	32.2	30.0
		D2	7.82	0.18	0.17	90.0	23.1	20.8
		D3	7.84	0.12	0.17	88.0	20.0	20.0
	C2 (5%)	D1	7.80	0.21	0.25	93.8	32.4	32.0
		D2	7.82	0.18	0.22	90.0	29.0	22.0
		D3	7.86	0.12	0.12	89.0	20.1	16.0
	C3 (10%)	D1	7.80	0.22	0.30	95.2	36.0	33.0
		D2	7.84	0.17	0.22	94.7	32.5	27.0
		D3	7.86	0.10	0.14	90.6	20.4	19.0
	C4 (15%)	D1	7.79	0.24	0.33	102	37.0	33.9
		D2	7.80	0.19	0.22	99.0	25.0	20.0
		D3	7.82	0.10	0.13	97.0	20.0	20.0
	C5 (20%)	D1	7.70	0.25	0.39	102	40.0	38.0
		D2	7.79	0.20	0.20	100	29.0	18.2
		D3	7.80	0.19	0.11	92.0	23.2	16.9
K2 (50%)	C1(without)	D1	7.86	0.22	0.25	88.2	46.0	40.0
		D2	7.88	0.11	0.20	83.7	36.2	29.0
		D3	7.80	0.08	0.13	80.2	29.1	20.0
	C2 (5%)	D1	7.69	0.23	0.30	99.0	49.8	46.0
		D2	7.72	0.13	0.22	89.0	38.0	32.0
		D3	7.80	0.09	0.14	82.0	30.0	22.0
	C3 (10%)	D1	7.60	0.25	0.33	102	54.0	49.8
		D2	7.62	0.16	0.12	89.0	39.0	39.0
		D3	7.63	0.12	0.10	84.0	30.0	32.0
	C4 (15%)	D1	7.59	0.27	0.35	120	57.0	54.0
		D2	7.60	0.19	0.22	107	40.0	39.0
		D3	7.61	0.11	0.17	103	30.5	22.0
	C5 (20%)	D1	7.59	0.32	0.37	120	57.2	54.9
		D2	7.61	0.19	0.20	112	40.0	40.0
		D3	7.63	0.12	0.16	100	29.0	23.0
K3 (75%)	C1(without)	D1	7.88	0.22	0.39	130	48.0	57.0
		D2	7.90	0.16	0.22	122	40.0	40.0
		D3	7.91	0.11	0.19	120	30.0	30.0
	C2 (5%)	D1	7.82	0.23	0.39	132	52.2	60.3
		D2	7.84	0.19	0.12	130	50.0	40.0
		D3	7.85	0.09	0.12	125	40.0	20.0
	C3 (10%)	D1	7.80	0.27	0.40	134	55.0	62.6
		D2	7.79	0.20	0.22	128	42.0	60.8
		D3	7.76	0.15	0.14	120	40.0	40.0
	C4 (15%)	D1	7.70	0.29	0.41	132	57.0	63.0
		D2	7.79	0.20	0.19	132	50.2	56.0
		D3	7.78	0.12	0.11	129	43.5	39.5
	C5 (20%)	D1	7.60	0.30	0.45	136	59.0	63.0
		D2	7.70	0.25	0.20	136	50.0	50.0
		D3	7.72	0.13	0.11	134	45.0	20.0
K4 (100%)	C1(without)	D1	7.70	0.24	0.42	140	62.0	62.3
		D2	7.79	0.14	0.33	138	60.0	44.0
		D3	7.79	0.12	0.12	138	60.0	40.0
	C2 (5%)	D1	7.62	0.25	0.44	151	68.0	69.5
		D2	7.66	0.19	0.22	149	62.2	50.2
		D3	7.65	0.12	0.12	130	60.0	29.0
	C3 (10%)	D1	7.66	0.28	0.44	157	69.0	79.0
		D2	7.69	0.20	0.20	150	64.5	52.0
		D3	7.69	0.11	0.13	126	60.5	30.0
	C4 (15%)	D1	7.60	0.32	0.45	160	72.0	90.0
		D2	7.62	0.28	0.22	156	70.0	60.0
		D3	7.62	0.13	0.17	148	70.0	57.0
	C5 (20%)	D1	7.59	0.34	0.45	161	78.0	109
		D2	7.60	0.22	0.13	157	72.3	82.0
		D3	7.64	0.14	0.13	150	60.6	60.0
(A) K- fertilizers			0.030	0.007	0.030	0.130	0.170	0.720
(B) vinasse conc.			0.002	0.006	0.021	0.110	0.110	0.420
(C) depth			0.001	0.004	0.018	0.090	0.080	0.320
A*B			0.010	0.005	0.023	1.010	0.260	1.200
B*C			0.011	0.004	0.024	1.014	0.272	1.210
A*C			0.011	0.005	0.024	1.100	0.310	1.240
A*B*C			0.012	0.006	0.025	1.200	0.312	1.250

Generally, application of different concentrations of vinasse in presence of different rates of potassium mineral fertilizers (0, 50, 75 and 100 %) was significantly superior for increasing the availability of N, P and K as compared to control treatment (vinasse alone). Moreover, treatment of (K3 combined with C5) was superior as compared to control (vinasse alone) and other treatments. Similar results were obtained for both tested seasons.

5. Total phenol content.

Concerning the presence of total phenols within soil profile after harvesting of both peanut and carrot due to applied diluted vinasse, data presented in (Fig.1) indicate that values decreased gradually with depth. Generally, values of total phenol increased gradually by increasing the concentration of vinasse, as compared to control treatment. Of course, this may be due to the presence of two sources of soil phenolic compounds, the first from plant residues and the second from applied vinasse. These results agree with those of David and Geoffrey (2010) who reported that, the values of the phenolic compounds for surface soils layer was greater than that for sub soil surface layers, and reflected differences in the organic matter content of the soil samples. Also, this is in agreement with those Martens (2002), who pointed out that the total phenolic content of soil incubated with various plant residues increased as organic C increased. Moreover, the highest values of total phenols were recorded for the soil surface layer in presence of (20%) vinasse combined with (100% K-mineral fertilizers and 75 %). These values were still less than the maximum values of total phenol allowable in the soil to be uncontaminated (100 mg kg^{-1}) according to ILL. S. T. H.A. (2013). These results may be due to the bio degradation of phenolic compound by some soil microorganisms especially in the sandy soil which provide aerobic condition. These explanation was confirmed by Mahiuddin et al., (2011) who showed that, degradation of phenols is an important for removing such phenols from the soil thus reducing environmental pollution. So, we can conclude that biodegradation by microorganisms can destroy or render presence phenolic compounds. These results agree with those of BioBizz Worldwide (2011)

Finally, it can be conclude that the use of diluted vinasse as a source of K- fertilizers does not cause any bioaccumulation of phenol compounds and is easily decomposes in sandy soils; the phenolic components do not contaminate the sub soil surface .



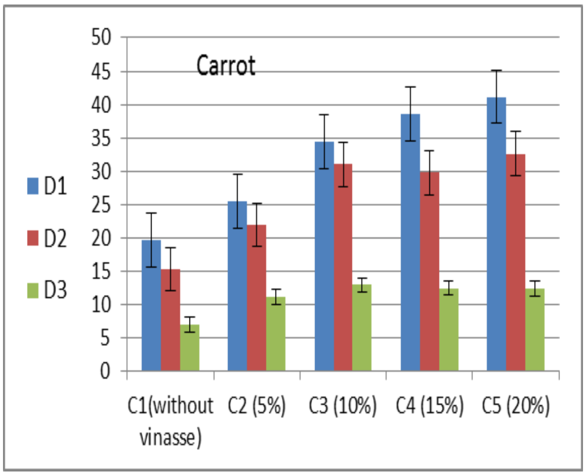


Fig. (1): Effect of applied diluted vinasse on total phenols (ppm) in soil profile layers after harvesting of both peanut and carrot crops.

2- Effect of diluted vinasse and different rates of k fertilizer on total N, P and K uptake in grown plants (kg fed^{-1})

Data presented in Tables (5, 6) show that nitrogen, phosphorus and potassium total uptake of peanut (straw , seeds) and carrot (shoots, roots), kg fed^{-1} respectively increased by adding different concentrations of vinasse and K- mineral fertilizers as compared to control treatments for both tested crops. However, high rate of vinasse C5 (20 %) combined with K3 (75%) recorded the highest values as compared to control and other treatments.

Interaction analysis revealed that the total uptake of N, P and K for peanut (straw , seeds) and carrot (shoots, roots) recorded the highest values due to appling of 75 % from the mineral K- fertilizers combined with diluted vinasse (20%) as compared to the control and other treatments, the lowest values being recorded with control treatment. Moreover, increasing rates of vinasse application progressively increase N, P and K uptake and this was parallel to their availability for both tested crops. Similar results were obtained by Arafat and Yassen (2002) who found that increasing rate of added vinasse had a significant positive effect on N, P and K total uptake in both straw and grains of wheat. This may be due to chemical changes in the soil and increasing the root distribution (Gomez,1996). Application of vinasse has a beneficial effect on soil physical, chemical and biological properties (Madejon et al., 2001).

As a conclusion, the total uptake of N, P and K in the studied plants generally increased gradually by increasing the concentration of vinasse from C1 to C5 and K- fertilizers from K1 up to K3, then the values slightly decreased with K4 as compared to the other treatments.

Table (5): Effect of applied diluted vinasse and different rates of k fertilizer on total uptake of N, P and K by peanut crop (kg fed^{-1})

Rate of K fertilizer	Conc. of vinasse	Straw N	Straw P	Straw K	Seeds N	Seeds P	Seeds K
Control		26.0	4.20	31.1	10.0	1.10	15.4
K1(without)	C1(without)	27.7	5.40	14.5	10.3	1.14	13.8
	C2 (5%)	36.1	6.40	22.2	11.0	1.22	15.2
	C3 (10%)	39.9	7.60	25.5	12.1	1.26	16.6
	C4 (15%)	49.9	9.80	29.8	12.5	1.51	18.0
	C5 (20%)	52.7	11.2	31.6	12.8	1.54	18.7
K2(50%)	C1(without)	36.5	6.20	20.6	10.6	1.12	15.8
	C2 (5%)	37.9	6.60	21.9	12.6	1.58	18.3
	C3 (10%)	39.5	7.40	22.7	14.3	1.54	18.1
	C4 (15%)	49.4	9.60	27.7	13.1	1.60	18.4
	C5 (20%)	64.5	15.0	40.2	14.4	1.49	19.1
K3(75%)	C1(without)	39.4	7.00	24.2	11.2	1.11	15.0
	C2 (5%)	61.1	10.6	37.4	13.8	1.56	19.6
	C3 (10%)	62.9	11.4	38.4	14.9	1.43	20.6
	C4 (15%)	64.4	12.2	40.4	15.4	1.57	21.7
	C5 (20%)	83.8	16.8	61.8	16.5	1.98	25.0
K4(100%)	C1(without)	48.1	7.80	30.0	13.0	1.23	16.7
	C2 (5%)	50.7	7.80	36.0	12.4	1.23	17.9
	C3 (10%)	62.6	12.4	44.3	12.5	1.28	19.2
	C4 (15%)	73.1	14.0	61.9	13.9	1.72	19.5
	C5 (20%)	62.9	13.6	59.0	13.0	1.31	19.0
L.S.D 0.05%	(A) K- fert.	0.320	0.130	0.360	0.220	0.081	0.400
	(B)Vinasse conc.	0.280	0.100	0.220	0.190	0.070	0.390
	A*B	0.390	0.140	0.280	0.330	0.120	0.590

Table (6): Effect of applied diluted vinasse and different rates of k fertilizer on total uptake of N, P and K by carrot crop (kg fed^{-1})

Treatments: Rate of K fertilizer	Conc.of vinasse	Shoot N	Shoot P	Shoot K	Root N	Root P	Root K
Control		28.8	6.00	20.0	29.2	7.00	44.5
K1(without)	C1(without)	7.80	2.51	7.20	12.6	3.33	12.5
	C2 (5%)	14.5	3.63	8.40	23.4	7.15	14.2
	C3 (10%)	27.5	4.34	8.54	27.4	8.83	14.8
	C4 (15%)	33.7	5.52	9.30	17.2	9.43	17.2
	C5 (20%)	37.0	6.38	9.71	45.9	19.1	20.1
K2 (50%)	C1(without)	34.2	4.28	10.2	41.3	9.62	17.5
	C2 (5%)	37.8	5.82	15.8	42.6	10.7	22.5
	C3 (10%)	51.0	6.67	19.3	48.4	13.9	29.5
	C4 (15%)	59.8	7.70	20.0	51.8	14.5	30.0
	C5 (20%)	56.0	8.39	26.9	56.7	14.8	35.2
K3 (75%)	C1(without)	41.5	7.23	18.7	47.2	11.9	30.4
	C2 (5%)	46.2	8.37	22.8	52.5	13.4	37.5
	C3 (10%)	58.8	8.55	28.4	59.4	14.0	52.3
	C4 (15%)	53.7	11.30	30.5	62.0	14.3	68.5
	C5 (20%)	56.3	11.70	35.9	72.0	18.5	72.4
K4 (100%)	C1(without)	22.7	5.13	22.0	30.0	8.30	38.2
	C2 (5%)	32.0	7.01	24.4	41.2	12.2	38.1
	C3 (10%)	41.0	7.80	28.7	41.4	12.6	51.2
	C4 (15%)	56.0	11.0	32.0	59.5	18.9	60.0
	C5 (20%)	54.0	11.0	30.8	52.5	18.9	52.0
L.S.D 0.05%	(A) K- fert	0.221	0.110	0.270	0.320	0.120	0.400
	(B) Vinasse conc.	0.210	0.100	0.240	0.270	0.100	0.390
	A*B	0.240	0.120	0.310	0.390	0.130	0.500

3- Effect of applied diluted vinasse and k fertilizer rates on yield components of peanut and carrot crops

As for the effect of application of different K-mineral rates of fertilizers, data presented in Tables (7, 8) reveal that, the crop yield components increased significantly by increasing the rates of K-fertilizers application from K1 up to K3 then the yield components slightly decreased as compared to control and other treatments.

Table (7): Effect of applied diluted vinasse and different rates of k fertilizer on total yield components for peanut crop (Ton $fed.^{-1}$)

Treatments		Yield Tons fed^{-1}		
Rate of K fertilizer	Conc. of vinasse	Pods	Straw	Total
Control		2.67	6.95	9.62
K1(without)	C1(without)	2.28	4.16	6.44
	C2 (5%)	2.40	4.74	7.14
	C3 (10%)	2.82	5.16	7.98
	C4 (15%)	2.85	6.50	9.35
	C5 (20%)	2.86	6.54	9.40
K2(50%)	C1(without)	2.55	4.17	6.72
	C2 (5%)	3.03	5.09	8.12
	C3 (10%)	3.17	6.35	9.52
	C4 (15%)	3.19	7.31	10.5
	C5 (20%)	3.21	7.62	10.83
K3(75%)	C1(without)	2.54	5.44	7.98
	C2 (5%)	3.18	6.48	9.66
	C3 (10%)	3.40	6.87	10.27
	C4 (15%)	3.48	7.91	11.39
	C5 (20%)	3.93	9.25	13.18
K4(100%)	C1(without)	2.82	5.86	8.68
	C2 (5%)	2.91	7.03	9.94
	C3 (10%)	3.26	7.24	10.50
	C4 (15%)	3.54	7.90	11.44
	C5 (20%)	3.42	7.55	10.97
L.S.D 0.05%	(A) K- fert	0.110	0.120	
	(B) Vinasse conc.	0.200	0.110	
	A*B	0.260	0.133	

Table (8): Effect of applied diluted vinasse and k fertilizer rates on total yield components for carrot crop (Tons fed^{-1}).

Treatments		Yield Tons fed^{-1}		
Rate of K fertilizer	Conc. of vinasse	Shoots	Roots	Total
Control		7.00	8.10	15.1
K1(without)	C1(without)	1.00	3.00	4.00
	C2 (5%)	4.00	6.30	10.3
	C3 (10%)	6.00	8.80	14.8
	C4 (15%)	8.90	9.10	18.0
	C5 (20%)	9.00	12.9	21.9
K2(50%)	C1(without)	8.00	10.8	18.8
	C2 (5%)	9.80	11.8	21.6
	C3 (10%)	11.00	12.8	23.8
	C4 (15%)	12.00	14.9	26.9
	C5 (20%)	13.00	15.2	28.2
K3(75%)	C1(without)	10.00	13.0	23.0
	C2 (5%)	11.00	14.0	25.0
	C3 (10%)	13.00	17.0	30.0
	C4 (15%)	13.50	17.5	31.0
	C5 (20%)	14.00	18.0	32.0
K4(100%)	C1(without)	6.10	9.00	15.1
	C2 (5%)	7.00	11.0	18.0
	C3 (10%)	9.00	11.0	20.0
	C4 (15%)	13.0	16.0	29.0
	C5 (20%)	12.5	14.0	26.5
L.S.D 0.05%	(A) K- fert	0.170	0.160	
	(B) Vinasse conc.	0.120	0.140	
	A*B	0.220	0.260	

Concerning the effect of vinasse concentration, data reveal that the values of peanut and carrot yield components generally increased significantly in case of treatments receiving high concentration of vinasse as compared to low concentration, C5 being best possibly due to better nutritional elements needed for plant growth (Arafate and Yassen, 2002). Besides vinasse may be considers as soil conditioners, which improve the nutrient uptake and yield (Omar et al., 2000).

Interaction analysis revealed that the high concentration of vinasse (20%) combined with K-mineral fertilizers (K3, 75 %) recorded the highest values of yield components for both peanut and carrot crops as compared to other treatments, the most inferior treatment was K1 combined with C1 as compared to control treatment. Again, vinasse amendment should give favorable physical condition to improve plant growth and yield.

As a conclusion, results indicate that the application of diluted vinasse to sandy soil has added significant amount of nutrients, especially K, and organic matter which improved soil chemical properties, nutritional status and crop yield. 25% from the potassium mineral fertilizer required for peanut and carrot may be reduced by the use of diluted vinasse (20%).

CONCLUSION

The work suggested that, the application of diluted vinasse to sandy soil has added significant amount of nutrients especially K and organic matter which improved soil chemical properties, nutritional status and crop yield. 25% from the potassium mineral fertilizer required for peanut and carrot can be reduced by the use of diluted vinasse (20%). Also, the use of diluted vinasse as a source of K- fertilizers does not cause any bioaccumulation of phenol compounds in the soil profile because of easily decomposition in sandy soils. So, phenolic components presences in diluted vinasse do not contaminate the sub soil layer.

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التقيم الزراعى لاستخدام الفيناس المخفف كمصدر للتسميد البوتاسي لمحصولى الفول السودانى والجزر

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اقيمت تجربة حقلية فى محطة البحوث الزراعية بالاسماعيلية – القاهرة – تم زراعة محصولين متتالين الفول السودانى والجزر , فى ارض رملية تحت نظام الرى بالتنقيط لتقيم استخدام الفيناس المخفف (وهو ناتج ثانوى من صناعة السكرواستخراج الكحول الايثيلى من المحاصيل السكرية) كمصدر للتسميد البوتاسى لتقليل وخفض التسميد البوتاسى المعدنى وقد تضمن البحث تتبع حركه الفينولات خلال طبقات التربة فى القطاع الارضى . اضيف المعدل الموصى به من التسميد للمعاملة الكنترول لمحصولى الفول السودانى والجزر على الترتيب،كذلك اضيف النيتروجين والفوسفور بالمعدل الموصى بـه لجميع المعاملات بينما اضيف التسميد البوتاسى المعدنى باربعة معدلات (بدون ،50 % ،75 % ,100 % من المعدل الموصى بـه) واضيفت هذه النسب بصورة مجتمعة مع خمسة تركيزات من الفيناس المخفف.

قدرت بعض الصفات الكيماوية بالتربة متضمنة رقم الحموضة والتوصيل الكهربى ومحتوى الماده العضوية وتيسر العناصر(نيتروجين وفوسفور وبوتاسيوم) وكذلك الفينولات الكلية و معدل امتصاص العناصر والمحصول الكلى بعد حصاد كلا المحصولين الفول السودانى والجزر. اوضحت النتائج ان استخدام الفيناس المخفف مع التسميد البوتاسى المعدنى ادى الى انخفاض طفيف فى قيم الحموضة وكان هذا الانخفاض تدريجى بزيادة تركيز الفيناس المضاف بينما زادت قيم التوصيل الكهربى والماده العضوية بزيادة تركيز الفيناس المضاف وفى وجود التسميد البوتاسى المعدنى .

اوضحت النتائج ان المعاملـه (75 % من التسميد البوتاسى المعدنى الموصى بـه مع الفيناس المخفف 20%) كانت افضل المعاملات حيث اعطت اعلى معدل تيسر للعناصر (نيتروجين وفوسفور وبوتاسيوم) وكذلك محتوى النبات من العناصر والمحصول الكلى للفول السودانى والجزر بالمقارنة بالكنترول وباقى المعاملات.

وبصفة عامة , فان اضافة الفيناس المخفف للاراضى الرملية لـه تاثير ايجابى على تيسر العناصر (نيتروجين وفوسفور وبوتاسيوم) وكذلك الفينولات خاصة فى الطبقة السطحية بالمقارنه بالطبقات التحت سطحية, وقد حدثت زياده تدريجية لامتصاص العناصر ومكونات المحصول بزيادة تركيز الفيناس من التركيز الاول وحتى الخامس وبزيادة معدل التسميد البوتاسى من المعدل الاول وحتى الثالث , ثم حدث انخفاض طفيف فى امتصاص العناصر والمحصول مع اضافة 100 % من التسميد البوتاسى المعدنى مع تركيزات الفيناس المختلفة.

وفى النهاية فان اضافة الفيناس المخفف للاراضى الرملية ادى الى اضافة كميات معنوية من العناصر لهذه الاراضى وخصوصا البوتاسيوم والمادة العضوية والتى ادت الى تحسن للخواص الكيميائية والحالة الغذائية والمحصول الكلى ، وبالتالى يمكن خفض 25 % من الاحتياجات من التسميد البوتاسى المعدنى لمحصولى الفول السودانى والجزر باستخدام الفيناس المخفف بمعدل 20 %. علاوه على ذلك ، فان استخدام الفيناس المخفف للاراضى الرملية امن على البيئة ولا يسبب اى تراكم للمركبات الفينولية فى الاراضى الرملية وهذة المركبات الفينولية لا تسبب تلوث للطبقات التحت سطحية وبالتالى الماء الارضى.