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MAXIMIZING USE OF VINASSE AND FILTER MUD AS BY-PRODUCTS OF SUGAR CANES ON WHEAT PRODUCTION

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ABSTRACT

In Egypt a simple and economical method to get rid of industrial by product particularly vinasse and filter mud is to use them through special means for agricultural practices in more comprehensive program of land reclamation. Greenhouse experiment was conducted to assess and evaluate the nutritional value of vinasse and filter mud. The obtained data revealed that addition of vinasse and filter mud to sandy soil increased the productivity of wheat plant. The results indicated that application of vinasse (20ml/l) gave the highest yield production . The addition of filter mud compind with vinasse caused a significant increase in both grain and straw of wheat as compared with the addition only of either vinasse or filter mud .The data pointed out that filter mud application gave a slight increase in total nitrogen grains content only. However, application of vinasse at rate of 0.5, 1and 2% had approximately the same effect on N content in both grains and straw as compared with control . Results also, showed that pronounced increase in P with vinasse application at a rate of 0.5 %. Finally, it could be concluded that vinasse and filter mud are a good source of available N, P and K when applied to soil and its application may reduce the amount of fertilizers by about for optimum wheat yield.

Keywords: Fertilizing Efficiency, Sugar cane, Vinasse and Filter mud

INTRODUCTION

Disposal of industrial wastes and by-products is an increasing concern for most industries. Disposal of vinasse has become a problem in sugarcane-growing countries where the distilling industry has recently expanded. Vinasse contains many useful elements and can be profitably recycled to improve soil properties and accordingly increase crop yield in addition to alleviating environmental pollution (Pande *et al.*, 1995). Worldwide, the interest in using sugarcane by-products is growing, to decreasing in production costs and environmental liabilities.

Gomez (1996) stated that, vinasse increased sugarcane yield significantly without reducing quality. He also suggested that vinasse could substitute for 55% of N, 72% of P and 100% of K required for sugarcane in Venezuela. Korndorfer and Anderson (1993) stated that application of vinasse increased significantly the sugarcane, wheat pigeon pea and maize yield as well as N, P, K, S and Ca uptake; however, the predominant effect was mainly to K and S.

In Egypt, the Sugar and Iintegrated Industries company (Hawamdyia) produce more than 2000 m^3/day of vinasse. It represents residues from molasses fermentation processes. Vinasse as an industrial waste represent a problem for its disposal from sugar industries. The large amount of vinasse

can harm the environment, causing salinization and river Nile pollution. Therefore, it was thought useful to try using it in agriculture

In the manufacture of sugar cane, the precipitated impurities contained in the cane juice after removal by filtration, from a cake of varying moisture content is called filter mud . Cake contents much of colloidal organic matter that precipitate during clarification . The amount of filter mud and its composition varies greatly with the variety of cane, milling efficiency , method of clarification , etc (Paturau 1989).

In Egypt also, a tremendous mass of filter mud about (0.5 million tones /year) as a by – products obtained from the clarification of cane juice in sugar industries. These waste residues present a problem for disposal ; therefore it was though useful to use such residues as an organic source . Sugar cane filter mud contain a considerable amount of plant nutrients mainly nitrogen. (Arafat *et al.*, 1992 and Arafat 1994).

Sugar cane filter mud is a good source of available N when applied to soil and its application cane reduce the amount of fertilizer nitrogen required for optimum crop yield , and play a role in decreasing the pollution effect of excessive N- mineral fertilizer in soil (Arafat *et al.*, 1997).

The objective of this study is to evaluate the nutritional value of vinasse and filter mud as well as their effect on nutrients uptake and yield of wheat.

MATERIALS AND METHODS

A pot experiment was conducted on sandy soil in the greenhouse to evaluate the effect of vinasse and filter mud on the yield and nutrients uptake of wheat. The experimental design was randomized complete block with three replicates in plastic pots, (30cm x 30cm) each pot contained 8 kg of air dried soil. This soil was classified as *typic torripsamments* (sand 92.9 %, silt 5.3% and 1.8% clay) with pH (1:2.5 H_2O) 8.25, EC 5.8 dsm^{-1} (1:1), organic matter 0.69 %, $CaCO_3$ 3.6 %, CEC 8.8 meq^{-1} 100gm soil, total N 0.02 %, total P 0.69 % $NaHCO_3$ extractable P 11.9 mg kg^{-1} soil, , total k 0.21 % and 352 mg kg^{-1} soil NH_4 OAC extractable K.

Some chemical properties of distillery vinasse and filter mud used in this study methods described by the U.S. salinity Lab Staff (1954) are presented in Table (1).

Three levels of diluted vinasse i.e., 0.5%, 1% and 2% were used in irrigation. tab Water, available in experimental site, was used to dilute the vinasse to get water with different fertilizer levels.

Treatments were as follows, control (without addition vinasse, filter mud and fertilizers applied), reference fertilizer of N PK (100, 5O and 5O mg kg^{-1} soil) added as NH_4NO_3, $Ca(H_2PO_4)_2$, $CaSO_4$ and K_2SO_4 respectively and the investigated vinasse, added in three rates(0.5 ,1 and 2%) in irrigation water while filter mud was applied to the soil in one rate (2.5 % from the soil weight) mixed with soil. The total amount of irrigation water was 13.5 L/pot along the period of plant growth. Before sowing, the soil was equilibrated for one week at 60 % moisture of the max. water holding capacity. After the

equilibration, twenty seeds of wheat plants (*Triticum aestivum* L., cv Seds 3) were sown in each pot and the seedlings thinned to 5 plants per pot after emergence. At the maturity stage, the plants were harvested and separated into grain and straw. Dry weights were recorded and prepared for analysis. Samples were digested with acid mixture. Total nitrogen in plant and KCl extractable N of soil were determined according to method described by Bremner and Mulvany (1982). P, K and Mg were determined according to method described by Cottenie *et al.* (1982).

Statistical analyses of all results were conducted using (NLSD) according to Gomez and Gomez (1984).

Table (1): Some chemical characteristics of Vinasse and filter mud.

Characteristics	Vinasse	filter mud	Characteristics	Vinasse	filter mud
PH	4.43	6.88 (1:2.5water)	Total k	0.6 %	0.2 %
EC ds.m^{-1}	21.0	0.8 (1:5 water)	Total Ca	0.54 %	4.3 %
Organic Carbon	3.10 %	43.76 %	Total Mg	0.27 %	1.9 %
Organic matter	6.2 %	77.33 %	Total Na	0.068 %	-
Fulvic acid	0.83 %	-	SO4	0.6 %	-
Humic acid	0.32 %	-	Total Solids	90 mg L^{-1}	-
Total N	248 mg L^{-1}	2.01 %	Soluble Solids	83 mg L^{-1}	-
NH4	87 mg L^{-1}	333 mg/kg	Total COD	100 mg L^{-1}	-
NO3	182 mg L^{-1}	42 mg/kg	Soluble COD	85 mg L^{-1}	-
Total P	423 mg L^{-1}	1.78 %	Total BOD	39 mg L^{-1}	-
Soluble P	185 mg L^{-1}	1680 mg/kg	Soluble BOD	35 mg L^{-1}	-

RESULTS AND DISCUSSION

Wheat yield production in relation to vinasse and filter mud application

Data in Table (2) represent the wheat production under different treatments of vinasse and filter mud. The addition of vinasse and filter mud within all tested rates, resulted in significant increase in grains, weight of 100 grain and straw yields of wheat compared to control treatment. Data also indicated that addition of filter mud decreased grains and straw yield compared to vinasse addition However, there were no significant differences in wheat yield between reference fertilizer and vinasse treatments. The increase in total wheat yield in vinasse treatments over control (N_0 P_0 K_0) ranged between 66% to 74%, while in reference fertilizer treatment was 66%. Also, it seen from data in table: that 2% of vinasse applied in irrigation water caused highly significant increase in wheat grains yield. The percentage increase in grains yield over control was 66%. However, the differentiation between the values of grains yield was very close for all tested rates of vinasse applied and references fertilizer treatment. The percentage increase in grain yield over reference fertilizer (N_2 P_1 K_1) treatment was 6% for at rate of 2% vinasse applied. From the above-mentioned results, the increasing of wheat yield as a result of vinasse application may be attributed to better growth under favorable physical condition of treated soil and can be related to the beneficial affect of vinasse containing a considerable amount of organic

matter and nutritional elements for plant growth. Similar finding was observed by Pande (1994) and Gomez (1996), who reported that the use of vinasse in irrigation water to fertilize some crops (wheat, sugar cane, pigeon, pea) caused a significant increase in yield compared to commercial liquid fertilizers of N, P and K.

Concerning the effect of filter mud with vinasse, data show that a significant increase in grain and straw of wheat comparing with addition of vinasse and filter mud alone. From table (2),it can be noticed that the most favorable treatment on grain and 100grain weight yield was FM + Vinesse (at rate 0.5 %) followed by FM +Vinasse(at rate 2 %) while the most favorable treatment on straw yield was FM +Vinasse (at rate 1 %).

From the above mentioned results the improving of plant growth as a result of vinasse and filter mud application my be attributed to the effect of organic matter containing considerable amount of N and other nutrient elements for plant growth (Arafat *et al.*, 1992)

Table (2): Effect of vinasse and filter mud treatments on grain and straw yield of wheat.

Treatments	Yield g/ pot		Weight of 100 grain(g)	Grain/ Straw Ratio
	Grain	Straw		
Control (N_0 P_0 K_0)	9.7	19.4	1.47	0.50
Vinasse I	14.6	33.8	3.62	0.43
Vinasse II	15.0	35.0	3.51	0.43
Vinasse III	16.1	34.4	3.95	0.47
Filter mud (F M)	13.8	28.0	2.87	0.49
F M + Vinasse I	19.5	36.8	4.28	0.53
F M + Vinasse II	17.9	37.2	3.63	0.48
F M + Vinasse III	18.7	35.0	4.00	0.53
Reference Fert .N_2 P_1 K_1	15.2	33.1	3.23	0.46
L.S.D. 0.05	2.52	4.85	0.741	-

Addition rate of vinasse in irrigation water (v/v) Addition rate of Filter mud 2.5 %

Plant composition

The effect of vinasse and filter mud on N concentration and its uptake by wheat plants are shown in tables (3 and 4). Data show that application of vinasse at a rate 0.5% 1% and 2% had approximately the same effect on N content in both grains and straw relative to reference fertilizer treatment. Data also, pointed out that filter mud application gave a slight increase in both total N in grains but in straw it is noticed that 2% of vinasse increased total N in straw as compared to filter mud treatment. The value is almost equal to reference fertilizer. While increasing rates of vinasse application progressively increased N uptake and this was parallel to the grains and straw yield increase. This finding could be explained by the fact that the total amount of inorganic N added within vinasse along the growing period was sufficient to meet most of the N required for wheat crop, especially at application rate 2% vinasse. In this respect, Gomez (1996) reported that vinasse could substitute for 55% of N required for sugarcane yield.

With respect to the effect of vinasse at different rate combined with filter mud ,data pointed out that applying the two sources with each other gave a higher increase in total N for both grain and straw compared to vinasse or filter mud applied alone. The same results were observed in N

uptake . The pronounced increase in N content and uptake was noticed when filter mud was combined with1% of vinasse. These results could be explained by the positive effect of filter mud and vinasse on improving nutritional status of sandy soil also due to rapid mineralization of this organic matter, Cooper and Abu Idris (1980).

With regard to the P content in both grains and straw of wheat, a pronounced increase in P was observed with 2% vinasse applied. Plant P concentrations increased continuously with increasing vinasse rate applied from 0.5% to 2% while P content was decreased in grain and straw when filter mud was added. Whereas when vinasse combined with filter mud, the P content in grain and straw was higher than when each of them was added alone . Increasing rate of vinasse up to 2% had a significant increase in uptake in both grain and straw in comparison to 0.5%. This indicates that the P uptake was positively affected by the rate of vinasse applied, this may be due to the increase in P content in vinasse amended soil (Table 1), enhanced microbial activities which increase nutrients availability and their uptake, and increasing root distribution. These results are in good agreement with that obtained by Gomez (1996) and Orlando (1996), they stated that the application of vinasse can provide added nutrients to sugarcane, similar to mineral fertilizers application, besides the benefits of organic matter and micronutrients addition to the soil. Whereas filter mud gave the lower P uptake for both grains and straw. Also, table (4) indicated that applying filter mud with vinasse gave higher P uptake when compared with vinasse or filter mud alone . The higher P uptake in grains was noticed when filter mud was applied at 2% vinasse but in straw when filter mud was applied at 1% vinasse.

Table (3): Effect of vinasse and filter mud treatments on nutrients content in wheat Plants (pot)

Treatments	Nutrients content %					
	Grains			Straw		
	N	P	K	N	P	K
Control (N_0 P_0 K_0)	1.31	0.28	0.65	0.23	0.08	2.42
Vinasse I	2.00	0.37	0.73	0.55	0.09	3.32
Vinasse II	2.25	0.40	0.79	0.60	0.09	3.45
Vinasse III	2.14	0.41	0.76	0.67	0.11	3.44
Filter mud (F M)	2.33	0.35	0.84	0.62	0.10	3.23
F M + Vinasse I	2.82	0.39	0.89	0.66	0.13	3.75
F M + Vinasse II	2.70	0.45	0.92	0.82	0.14	3.64
F M + Vinasse III	2.61	0.48	0.91	0.79	0.13	3.79
Reference Fert .N_2 P_1 K_1	2.24	0.44	0.76	0.62	0.09	3.32

Potassium concentration and uptake in wheat plants exhibited several differences, but consistent trends (Tables3 and 4). The values of K concentration in grain yield of wheat were increased slightly by high vinasse rates. The magnitude variation of K concentration in straw with respect to application of vinasse relative to control was very clear . The higher increase in K content was observed in grains and straw when filter mud was added but it decreased in straw .the highest K concentration (0.92 %in grain and

3.79%in straw) was recorded at 1% vinasse combined with filter mud and vinasse plus filter mud for both grains and straw respectively . The highest values of K uptake (122 mg pot^{-1}) was recorded at application of 2% vinasse, followed by 119 mg k pot^{-1} for 1% vinasse and 115 mg k pot^{-1} for reference fertilizer treatment (N_2 P_1 K_1). When filter mud was applied, it increased K uptake in grains as compared to 2% vinasse application but it decreased K in straw. The pronounced increase in K uptake was observed in grains and straw when filter mud was added with 0.5% vinasse. Also, data indicated that K uptake decreased when the ratio of vinasse combined with filter mud increased.

Table (4): Effect of vinasse and filter mud treatments on nutrients uptake by wheat plants.

Treatments	Nutrients content mg /pot					
	Grains			Straw		
	N	P	K	N	P	K
Control (N_0 P_0 K_0)	127	27.2	63	44	15.5	469
Vinasse I	292	55.5	107	185	30.4	1122
Vinasse II	338	66.0	119	210	31.5	1208
Vinasse III	345	66.0	112	230	37.8	1183
Filter mud (F M)	322	59.4	116	174	28.1	906
F M + Vinasse I	551	76.3	174	243	47.9	1382
F M + Vinasse II	485	80.9	165	305	47.9	1356
F M + Vinasse III	488	89.8	170	276	45.2	1326
Reference Fert .N_2 P_1 K_1	340	66.9	115	205	30.0	1099

Chemical Characteristics of Soil after Harvesting

Table (5), summarizes the effect of vinasse, filter mud and the combination of them on some chemical characteristics of the treated soil after cropping. Concerning the pH, it was observed that the application of vinasse and filter mud to the investigated soil had slight effect on soil pH. The effect on pH may be explained by the production of the organic acids and hydrogen ion (H^+). The decomposition process accelerates the release of CO_2 and organic acids that would reduce soil pH. This finding confirms those obtained by El-Leboudi *et al.* (1988) and Arafat (1994). Data also show that the soluble salts (EC) values of the untreated and treated soil decreased after cropping. These results could be attributed to the amount of water applied during the growth period of crop, consequently more elements are dissolved and taken by plants as well as more salts are leached out from the root zone.

The most striking change was the tremendous increase in soil organic matter content, as a result of treating the soil with vinasse and filter mud especially at higher rate of vinasse application. The percentage increase in organic matter content was 49% at applied rate 2% relative to control. While The percentage increase in organic matter content was 85% at applied filter plus vinasse at rate 2%. Similar results were obtained by Orlando Fillo (1996), who stated that addition of vinasse to soil led to an increase in the amount of organic matter content.

It was observed that the extractable concentration of NPK in the soil treated with vinasse and filter mud increased relative to non-treated soil. The rate of increase depends mainly on the rate of vinasse and filter mud

application. The magnitude variation of residual extractable Potassium with respect to application rate of vinasse and filter mud ware observable. Highest value of extractable K (740 mg kg –1 soil) at 2% of vinasse was recorded. The greatest increase in extractable values of K is most probably due to presence of vinasse this is agreement with those obtained by Zende *et al.* (1995) and Kwong *et al.* (1997).

Table (5): Some chemical characteristics of soil investigation after wheat harvesting.

Treatments	pH	EC dSm^{-1}	OM %	Nutrients content mg kg^{-1} soil		
				Inorganic N	*Ext. P	**Ext. K
Control (N_0 P_0 K_0)	8.31	3.67	0.73	14.5	5.62	296
Vinasse I	8.25	3.82	0.83	19.3	7.83	521
Vinasse II	8.24	4.22	0.91	24.3	10.2	674
Vinasse III	8.12	4.28	1.14	30.0	11.9	740
Filter mud(FM)	8.15	3.44	1.11	22.3	9.9	552
F M + Vinasse I	8.14	4.75	1.18	34.3	10.7	675
FM + Vinasse II	8.19	5.29	1.84	36.2	11.2	781
FM+ Vinasse III	8.23	4.22	1.92	39.7	12.1	815

*$NAHCO_3$ extractable P **NH_4OAC extractable K

Finally, it could be concluded that application of vinasse and filter mud to field crops is a viable method for its disposal. Also, it had direct effect as a good source of element and an indirect effect consisting of an improvement of utilization of absorbed nutrients. It is obvious that vinasse may be used as K fertilizer.

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الاستخدام الأمثل لمخلفات صناعة قصب السكر (الفيناس- طينة المرشحات) اثر ذلك على إنتاجية نبات القمح

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تعتبر مخلفات صناعة قصب السكر (الفيناس – طينة المر شحات) إحدى النواتج الثانوية إذ تنتج بكميات كبيرة الأمر الذى سوف يؤدى إلى أضرار بيئة يصعب حلها وعلى ذلك أجريت تجارب فى المركز القومى للبحوث الهدف منها الاستفادة من القيمة الغذائية حيث تحتوى تلك المخلفات على عناصر غذائية بالاضافة انها مادة غذائية يمكن الاستفادة منها وقد اوضحت النتائج الاتى :

- أدى إضافة الفيناس او طينة المر شحات كل على حدة الى زيادة المحصول من الحبوب او القش ال١٠٠ حبة مقارنة بالكنترول كما ان إضافة الفيناس مع طينة المر شحات ادى الى زيادة المحصول من الحبوب آو القش ال ١٠٠حبة مقارنة بالكنترول او التسميد المعدنى .
- أظهرت النتائج ان إضافة الفيناس بمعدل ٠,٥ % مع طينة المرشحات ٢,٥ % أعطت اكبر قيمه فى كل من المحصول ووزن ال ١٠٠ حبة مقارنة بمعدل ١ % من الفيناس مع نفس المعدل من طينة المرشحات .
- إضافة الفيناس وطينة المرشحات سواء كل منهما على حدة او مع بعضهم ادى الى زيادة تركيز النيتروجين الممتص مقارنة بالكنترول فى محصول الحبوب والقش .
- إضافة الفيناس بمعدل ٢ % سواء بمفرده او مع طينة المرشحات ادى الى زيادة الفوسفور الممتص فى محصول الحبوب .
- وجد أن إضافة الفيناس بمعدل ١ % مع طينة المرشحات ادى الى زيادة تركيز البوتاسيوم والممتص فى النبات .
- وجد أن إضافة الفيناس وطينة المرشحات ادى الى زيادة معنوية فى محتوى التربة بعد الحصاد من المادة العضوية والعناصر المغذية .

استخدام الفيناس وطينة المرشحات كمصدر للتسميد العضوى تعتبر من المواد المفيدة لما لها من آثار جيدة فى خصوبة الاراضى مع تقليل التأثير الضار من التلوث بالأسمدة المعدنية .