*Plant Archives* Vol. 19 No. 1, 2019 pp. 1593-1600 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

# SIGNIFICANT USE OF VINASSE AS A PARTIAL REPLACEMENT WITH CHEMICAL FERTILIZERS SOURCES FOR SPINACH AND BARLEY PRODUCTION AND THEIR EFFECT ON GROWTH AND NUTRIENTS COMPOSITION OF PLANT

**Safaa Abd el halim Mahmoud[1*], Hanan Salah Siam[1], Ahmed Said Taalab[1] and Soad Mahamed El- Ashry[2]**

[1*]Plant Nutrition Department, National Research Centre, Cairo, Egypt.
[2]Soil and water resource, National Research Centre, Cairo, Egypt.

## Abstract

Vinasse is a waste material from distillery industries which has lot of organic and inorganic compound. It is utilized in agriculture as a substitute for chemical fertilizers. In this work greenhouse experiment was conducted to study the effect of vinasse application in present or absent of different rate of nitrogen, phosphorus and potassium fertilizers on yield and nutrients status of spinach and barley plants. The result showed that, the vinasse application with fertilizers gave the highest fresh and dry matter than obtained conventional fertilization. Plant N, P and K content and its uptake increased when vinasse applied with traditional fertilizers. It could be concluded that vinasse could substitute for 50% of N, 40% of P and 100% of K required for Spinach or barley yield. The results showing $NO_3$ concentration decreased with vinasse treatment compared with mineral fertilization. Further it has been observed that $NO_3$ concentrations in the first cut with all treatments are higher than the secondary cut in barley and spanish plants.

***Key words*** *:* Vinasse, waste, Barley, Spanish and nutrients status.

## Introduction

Vinasse as industrial waste is being a problem for getting disposed of sugar industries. It represents the residues from molasses fermentation. In Egypt, the sugar and integrated industries company in Hawamdyia produces more than 2000 $m^3d^{-1}$ of vinasse. The amount of vinasse can harm the environment, causing salinization and pollution of the river Nile. The vinasse is condensed to dry material content of 60% which contains 3.5%N, 0.5% P, 6.5% K and 2.5% Na, this material has very high salt, electrical conductivity, EC 25-30 $dSm^{-1}$ (Laime *et al.,* 2011). A few years ago, vinasse was kept in evaporation ponds, which could cause environment problems (ground water contamination, strong smells, an appearance of insects and other nuisances). Currently vinasse are concentrated for subsequent use (animal feeding, potassium salt production). The excessive salt content (EC, 25-30 $dSm^{-1}$) of concentrated vinasse produced in southern Spain limits it's used for animal feeding. However, it's OM (350 $gkg^{-1}$), N (30 $gkg^{-1}$) and K (30$gkg^{-1}$) contents make it potentially useful as a fertilizer (Murillo *et al.,* 1993; Martin-Olmedo *et al.,* 1996).

Vinasse has high levels of potassium, calcium and organic matter in its chemical composition as well as moderate amounts of nitrogen and other nutrients (Gloria 1985) and could represent an alternative to supply nutrients for crop production (Gloria 1985; Garcia 1994). Sugarcane vinasse contains large amount of organic matter and may be effective in that respect. In general, this effluent consists of basically water (more than 90 %), organic solids (organic acids and sugars), and 7 % of minerals (K, Ca, and Mg) (Freire and Cortez 2000; Doelsch *et al.,* 2009; Gianchini and Ferraz 2009; Laime *et al.,* 2011). Sugarcane vinasse is used as a soil amendment to improve the physical, chemical, and biological attributes of soil

***Author for correspondence :** E-mail : safaaayman@yahoo.com

(Gemtos *et al.,* 1999 and Christofoletti *et al.,* 2013).

The researches carried out in the past decade in China showed the positive effect of vinasse application on growth and development of sugarcane, as well as the improvement in soil properties (Li *et al.,* 2008; Zhou *et al.,* 2008; Zhou *et al.,*, 2009; Ao *et al.,* 2009; Mo *et al.,* 2009; Meng *et al.,* 2009). Li *et al.,* (2008) found that the vinasse obtained from sugar industry can be utilized as a complete fertilizer for the growth of sugarcane, and they also showed that the application of fresh vinasse in the fields, without any dilution or pretreatment, could significantly increase the cane yield and sucrose percent cane and reduce the chemical fertilizer application and production cost. Vinasse (beet-cane) is a by-product of the distillation of alcohol liquors and from yeast and amino/ organic acid production through the fermentation of sugarcane and/or sugar beet molasses, a by-product of sugar manufacturing. Studies of the use of molasses vinasse as an agricultural fertilizer have been documented, since the 1940 Studies indicate that vinasse is high important minerals, vitamins, and organic acids necessary for crop production and improves the soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances (Decloux, 2002 and Gopal and Kammen, 2009). Vinasse (beet, cane) contains no toxic chemicals. Oral, dermal and inhalation toxicity is rated as not applicable. Vinasse is not carcinogenic. There is no bioaccumulation of vinasse or components of vinasse as it easily decomposes by micro-organisms in soil or water. Because of the high decomposition rate of the organic matter, the components of the material do not accumulate.

Many studies exist reporting that vinasse is a good fertilizer, a potential source of organic matter and plant nutrients, especially for its P and K values, a soil conditioner which stimulates the growth of beneficial microorganisms in the soil, and allows better uptake of nutrients into the plant (Ao *et al.,* 2009).

Indicating vinasse is a potential source of organic matter and plant nutrients, especially for its P and K values and as a soil conditioner which stimulates the growth of beneficial microorganisms in the soil and allows better uptake of nutrients into the plant vinasse is mainly of plant origin, with some microbial residue (yeast). The components of vinasse are readily metabolized and utilized by micro-organisms as energy sources. Studies indicate that uncomposted cane vinasse, composted beet and cane vinasse, beet vinasse composted with raw manure or solid plant materials increases crop yield, structural stability of soils, soil microbial biomass, $CO_2$ respiration, rates N cycle functioning and enzymatic activities values, while exchangeable sodium percentage remained under critical sodicity values of about 15% (You *et al.,* 2009). In addition, when vinasse is composted with other agricultural wastes, decomposition rates increase. Studies also indicated that uncomposted beet vinasse in general has higher salinity rate values than cane vinasse and, when applied to soil in high volume, decreases soil physical and biological properties and crop yield (F. obono *et al.,* 2016). Since 1980, environmental awareness has promoted more stringent requirements for proper disposal or renewable resource recovery of the large amounts of solid waste (bagasse, pulp) and waste waters (molasses, vinasse). Vinasse is used as feedstock in biofuel production and as an agricultural fertilizer and the soil conditioner. Vinasse has important qualities as an organic fertilizer, containing macro nutrients such as nitrogen, potassium, calcium sulfate and magnesium, and chelate organic material with micronutrients such as iron, manganese, zinc, and copper. Due to the high content of complex B vitamins and amino acids from yeast autolysis, vinasse is also used as soil conditioner for the production of beneficial microorganisms in the soil and as an ingredient in the animal feed formulations (Madejon *et al.,*1995).

Barley (*Hordeum vulgare* L.) is a major cereal crop primarily grown, but it also yields valuable forage that can be grazed, cut for hay or silage while still green, or cut after grain harvest as straw (Duke, 1983). The barley plant is an annual yield and tufted grass, up to 50 to 120 cm high, because of its good carbohydrate content, barley is easy to ensile and with a rapid fall in pH produces good quality silage (Helm *et al.,* 2002). Barley crop harvested at the soft-dough stage is suitable for silage (McLellan, 2011). However, when barley forage is intended for silage, the most important criteria is its moisture content, which must be between 64 and 72%. If the forage is allowed to get drier than this, it may result in difficulties in packing it tightly to ensure an anaerobic environment. Failure to do this can result in excessive heating and nutrient losses (Helm *et al.,* 2002).

Recent studies continue to underscore the amazing versatility of spinach. Because this leafy vegetable is rich in water-soluble vitamins, fat-soluble vitamins, minerals, and a wide variety of nutrients, there are many different ways to incorporate spinach into your meal plan and enjoy a variety of nutritional benefits.

New research is under way involving the nitrate content of spinach. You've probably heard about nitrate (and nitrite) in the content of food additives, since both of these nitrogen-containing substances have often been used as preservatives for deli meats. However, when nitrate is used as a food additive, it is usually in a concentrated (10 or more milligrams per 8 ounces) when compared with its naturally-occurring amount in certain foods. For example, even though spinach is a rich source of nitrate, its nitrate content usually totals far less than 1 milligram per 8 ounces. And at this lower, naturally-occurring level, the nitrate in spinach may actually provide us with health benefits (Hammad *et al.,* 2007). For example, bacteria in our saliva and in our lower intestine can convert nitrate ($NO_3$) into nitrite ($NO_2$) and nitrite into nitric oxide (NO), and this nitric oxide might in turn help to protect proper function of the intestinal lining. While we do not have definitive studies about this potential role of nitrate in spinach, this area of research is one of active interest. Spinach is extremely healthy and has been linked to numerous health benefits.

It has been shown to help decrease oxidative stress, improve eye health, aid in cancer prevention and help regulate blood pressure levels.

Spinach contains high amounts of nitrates, which may promote heart health (Wiedenhoeft, 2006).

This paper deals with the effect of vinasse sugar cane with fertilizers on crops (barley and spinach and on mineral composition in plants. Results were compared with those obtained under traditional mineral fertilizers.

## Materials and Methods

Pots were filled with eight kg of dry sand loamy soil sample was collected from NRC from in El-Nobaria Government. Some physical and chemical properties of the used soil and vinasse are determined by Cottene *et al.,* (1982) and represented in Table 1. Seeds of spinach (*Spinacia oleracea* L.) or barley (Giza 124 ) were sown in the pot by pressing them into the soil to a depth of 1 cm, Vinasse was applied with water irrigation by rate 2% at three times all the growth period with or without of inorganic fertilizers. The vinasse and inorganic fertilizers were supplied at sowing. Seven treatments comprised of vinasse and inorganic fertilizers *i.e.* 100% RDF (Recommended dose of inorganic fertilizers ($T_1$) control, vinasse ($T_2$), vinasse + Pk without nitrogen ($T_3$), vinasse +50%N - Pk ($T_4$),vinasse+50% (N+P)-K ($T_5$), vinasse+50% (N+k)-P ($T_6$) and vinasse + 50% RDF of ( N + P + K ) ($T_7$).

**Table 1:** General physicochemical properties of the sugar can vinasse and experiment soil.

| Parameter | pH | EC $dsm^{-1}$ | O.C% | O.M% | N % | $NO_3$mg/kg | P % | k % |
|---|---|---|---|---|---|---|---|---|
| Vinasse | 4.6 | 20 | 3.8 | 6.5 | 2.2 | 997 | 0.42 | 5.2 |
| Experiment soil | 7.97 | 2.66 | 4.17 | 0.12 | 0.15 | 150 | 0.007 | 0.012 |

Source of N was ammonium sulphate whereas P and K were applied through sodium dihydrophosphate ($NaH_2PO_4.H_2O$) and potassium sulphate. Vinasse was applied with water irrigation by rate 2% at three times all the growth period. Two cutting of crop were taking at the end of the growth period.

Crops were harvested for green folder and weight plants material at first cut (FC) and second cut (SC) and $NO_3$ was determination in the fresh matter by used deverda at Kjeddahl according method described by Cottenie *et al.,* (1982). Plants material was dried at 70°C after washing with water, Afterward, drying samples were ground. The nitrogen content was determined by Kjeddahl digestion. K was determined by a flame photometer and P by colorimetric determination. Collected data were analyzed statistically by ANOVA.

## Results and Discussion

Tables 2 and 3 shows the fresh weight (FW) and dry weight (DW) and Nitrate ($NO_3$) content in the first and second cut of barley and Spinach plants.

Application of vinasse alone significantly decreased the dry and fresh yield in the first and second cut of both barley and spinach plants compared with traditional mineral fertilizers ($T_1$), but when vinasse applied with fertilizers caused significantly increased in fresh and dry weight. Also, the addition of vinasse with 50% of N, P and k ($T_7$) increased significantly the mean weight of dry and fresh in barley and spinach plants compared with control ($T_1$).

This increased ranged between 20-26.3% in fresh

**Table 2:** Yield and nitrate content of Barley plant under the effect of treatment.

| Treatment0 | **FW (gm/pot) | | | **DW (gm/pot) | | | $NO_3$ mg/100gm | | |
|---|---|---|---|---|---|---|---|---|---|
| | FC | SC | M* | FC | SC | M | FS | SC | M |
| $T_1$ | 129 | 99 | 114 | 19 | 21 | 20 | 630 | 356 | 490 |
| $T_2$ | 117 | 96 | 107 | 16 | 20 | 18 | 465 | 140 | 303 |
| $T_3$ | 119 | 83 | 101 | 18 | 18 | 18 | 420 | 140 | 280 |
| $T_4$ | 135 | 105 | 120 | 20 | 22 | 21 | 490 | 280 | 525 |
| $T_5$ | 146 | 113 | 130 | 21 | 23 | 22 | 560 | 200 | 380 |
| $T_6$ | 121 | 100 | 111 | 19 | 21 | 20 | 560 | 300 | 430 |
| $T_7$ | 165 | 123 | 144 | 22 | 24 | 23 | 600 | 220 | 410 |
| LSD 5% | 3.99 | 3.31 | 3.5 | 1.72 | 3.03 | 2.5 | 11.5 | 5.9 | 10.5 |

Application of vinasse with 50% (N+P) without K was recorded to increase the means FW and DW of barley plant 14

**Table 3:** Yield and nitrate content of Spinach plant under different treatments.

| Treatment | FW(g/pot) | | | DW(g/pot) | | | $NO_3$ mg/100gm fresh | | |
|---|---|---|---|---|---|---|---|---|---|
| | FC | SC | M* | FC | SC | M* | FS | SC | M* |
| $T_1$ | 38 | 72 | 55.0 | 9.7 | 19.1 | 14 | 545 | 280 | 413 |
| $T_2$ | 35 | 66.5 | 52 | 9.4 | 16 | 13.2 | 575 | 140 | 358 |
| $T_3$ | 36.5 | 68 | 53 | 10.3 | 18.0 | 13.5 | 560 | 140 | 350 |
| $T_4$ | 43 | 77.6 | 61 | 11 | 19.6 | 15 | 750 | 310 | 530 |
| $T_5$ | 49 | 79 | 64 | 12 | 19 | 15.5 | 595 | 210 | 402 |
| $T_6$ | 41.5 | 70 | 56 | 10 | 18.2 | 14 | 700 | 420 | 560 |
| $T_7$ | 50.5 | 82 | 66.0 | 10.8 | 20.8 | 19.8 | 580 | 140 | 360 |
| LSD 5% | 3.13 | 2.27 | 2.8 | 1.63 | 1.18 | 1.5 | 9.58 | 2.59 | 6.5 |

* M (mean), ** FC (first cut) and SC (second cut).

**Table 4:** Nutrient concentration in barley plants under effect of treatments.

| Treatments | N% | | | P% | | | K% | | |
|---|---|---|---|---|---|---|---|---|---|
| | FC | SC | M | FC | SC | M | FS | SC | M |
| $T_1$ | 2.1 | 1.5 | 1.75 | 0.13 | 0.18 | 0.15 | 3.2 | 2.6 | 2.9 |
| $T_2$ | 2.1 | 1.62 | 1.86 | 0.13 | 0.16 | 0.14 | 3.4 | 2.9 | 3.2 |
| $T_3$ | 3.0 | 1.6 | 1.8 | 0.14 | 0.14 | 0.14 | 3.2 | 2.9 | 3.0 |
| $T_4$ | 2.0 | 1.84 | 1.9 | 0.14 | 0.13 | 0.13 | 3.5 | 2.8 | 3.1 |
| $T_5$ | 1.9 | 1.76 | 1.8 | 0.13 | 0.2 | 0.16 | 3.3 | 3.0 | 3.6 |
| $T_6$ | 1.8 | 1.75 | 1.77 | 0.13 | 0.14 | 0.13 | 3.3 | 2.7 | 3.0 |
| $T_7$ | 1.8 | 1.55 | 1.7 | 0.13 | 0.11 | 0.12 | 2.6 | 2.9 | 2.8 |

* M (mean), ** FC (first cut) and SC (second cut).

weight and 15-41% in dry weight for barley and spinach respectively.

Similar finding was observed by Rajagopal Vadivel *et al.*, (2014) who reported that optimized dose of vinasse application has significance over soil properties, crop qualities and yield improvement. Globally; it has high potential to substitute potassium and nitrogen nutrients to the present level annual consumption and substantial amount phosphorous, calcium, sulphur and micronutrients of crops. However, application of vinasse had a significant influence on plant dry matter in second cut than the first cut for barley and Spinach plant with all treatments.

**Table 5:** Nutrient concentration in spinach plant under effect of treatments.

| Treatments | N% | | | P% | | | K% | | |
|---|---|---|---|---|---|---|---|---|---|
| | FC | SC | M | FC | SC | M | FS | SC | M |
| $T_1$ | 1.36 | 1.4 | 1.38 | 0.16 | 0.10 | 0.13 | 3.1 | 2.2 | 2.7 |
| $T_2$ | 1.4 | 1.6 | 1.5 | 0.145 | 0.13 | 0.14 | 3.7 | 2.8 | 3.3 |
| $T_3$ | 1.6 | 2.1 | 1.8 | 0.173 | 0.12 | 0.15 | 2.9 | 2.2 | 2.6 |
| $T_4$ | 1.46 | 1.43 | 1.4 | 0.13 | 0.11 | 0.12 | 3.1 | 3.5 | 3.3 |
| $T_5$ | 1.3 | 2.0 | 1.6 | 0.13 | 0.11 | 0.12 | 2.5 | 3.6 | 3.1 |
| $T_6$ | 1.4 | 1.82 | 1.6 | 0.14 | 0.1 | 0.13 | 3.0 | 3.2 | 3.1 |
| $T_7$ | 1.4 | 1.2 | 1.3 | 0.14 | 0.1 | 0.12 | 2.6 | 3.0 | 2.8 |

* M (mean), ** FC (first cut) and SC (second cut).

and 10% over control (NPK) respectively. This might due to the vinasse compound has high concentration of K in its chemical composition and reduce the chemical fertilizer application, further, the vinasse application without nitrogen or phosphorus fertilizers decrease slightly in the means fresh and dry matter of barely, this values 11.4 and 10.0 % for $T_3$ when compared with control treatment ($T_1$).

Similar results found with Komdorfer and Anderson, 1993 who reported the vinasse application increased significantly N, P, K, S and Ca uptake as well as yield of sugarcane, wheat, pigeon pea and maize yield. Vegetable crops are sensitive to vinasse and irrigation by 33% dilution vinasse increased the fruit size and weight (Chidankumar *et al.,* 2009). Also, Vinasse practice of 80 $m^3$ $ha^{-1}$ in entisols to sugarcane crops is better than trash management and farmers practice by yield, soil C and nitrogen stocks improvement (Alexander *et al.,* 2006; Soobadarand and KeeKwong, 2012).

No significant differences have been observed with vinasse + 50% (P+K) and vinasse treatments at dry matter of barley and spinach plants but in some case the absent of K with vinasse supper yield than control (NPK) treatment, finally in dry and fresh matter of vinasse with 50% (N,P and K) treatment were significantly higher than control (NPK), this means (144, 23 gm/pot) for barley and (66, 19.8 gm/pot) for spinach, respectively, which clearly indicated that vinasse application in barley and spinach field can enhance the soil mineral content significantly.

The soil in this study deficient in mineral content and high concentration of K and moderate concentration of N, P in vinasse makes its application worth for this kind of soil. These results agree with Zhou *et al.,* (2009) who reported that after applying vinasse as base fertilization in sugarcane field could enhance the soil fertility, increase the cane and sugar yield and had no bad effects on ground water contents.

### Changes of Nitrate concentration

Nitrate concentration in barley and spinach plants indicates the degree of quality of barley silage and spinach food. The effect of vinasse application on $NO_3^-$ concentration of barley and spinach plant has been shown in Tables 2, 3. Nitrate concentrations in the first and the second

**Table 6:** Mean values of nutrient uptake (N, P) and K in barley and Spinach plants.

| Treatments | P mg/potK mg/pot | | | | N mg/pot | |
|---|---|---|---|---|---|---|
| | Barley | Spinach | Barley | Spinach | Barley | Spinach |
| $T_1$ | 36 | 18.2 | 580 | 378 | 350 | 193 |
| $T_2$ | 25 | 18.5 | 576 | 436 | 335 | 198 |
| $T_3$ | 25 | 16.2 | 540 | 351 | 324 | 202 |
| $T_4$ | 27.3 | 18 | 651 | 495 | 403 | 210 |
| $T_5$ | 35 | 18.6 | 572 | 480 | 396 | 248 |
| $T_6$ | 32 | 18.2 | 600 | 434 | 354 | 224 |
| $T_7$ | 30 | 23.7 | 644 | 554 | 391 | 257 |
| LSD 5% | 1.89 | 1.024 | 8.48 | 3.73 | 6.5 | 2.59 |

cuts are declined significantly in vinasse treatments compared to NPK (control) treatment. The lowest nitrate concentration was 280 and 303mg/100g with $T_3$ and $T_2$ in barley plants respectively, the same behavior in spinach plant.

Further, it has been observed that $NO_3$ concentrations in the first cut with all treatments are higher than secondary cut in barley and spinach plant this could be rendered to the dilution effect inside the plant tissue. The results also showed that $NO_3$ concenration decreased with vinasse ($T_2$) and vinasse + PK ($T_2$) treatments. (303, 280) compared with 490 mg/100g in NPK ($T_1$) treatment at barley plant. This phenomenon could be explained by the fact that vinasse can partially replace some mineral fertilization and the organic N of vinasse cannot be leached to the deeper layers at the soil and that it is delivered when the temperature rises in spring, the time needed by the plants (Debruck and Lewiski, 1985).

### Nutrient content and uptake in barley and Spinach plants

Data represent in table 4, 5, and 6 and fig. 1 and 2 indicates the values of N, P and K concentration and its uptake in barley and spinach plants in first and second cuts as affected by vinasse application with or without chemical fertilizers.

### Nitrogen

The results showed that nitrogen content and uptake as affected by vinasse applied in first and second cuts, generally. N-content in the first cut is higher than the second cut in the barley plant but it doesn't differ in spinach plant, also the application of vinasse was recorded to increase N, content and Nitrogen uptake in barley and spinach plant compared with NPK treatment ($T_1$). Application of vinasse with 50% (N + P + K)($T_6$ ) recorded to increase the N- uptake of barley and spinach by 11.7, and 33% over control ($T_1$) respectively., this might be due to application of vinasse increases availability of N,P,K special K,N in soil and then increase the its take up by plant and reduce the chemical fertilizer application and production cost (Meng *et al.*, 2009) vinasse application without K fertilizer ($T_2$ and $T_5$) don't affected on k-content and uptake by plant these value 3.2 and 3.6% and 576, 572 mg/pot for barley plant, because the application of vinasse instead of shortage the added nitrogen deficiency but applied the vinasse to the soil has a significant effect on the absorbed of potassium by plant.This results conform to Rajago

**Table 7:** Micronutrient content (ppm) of barley plant in first and second cuts.

| Treatments | Fe | | Mn | | Zn | |
|---|---|---|---|---|---|---|
| | F.C. | S.C. | F.C. | S.C. | F.C. | S.C |
| $T_1$ | 109 | 85 | 16 | 58 | 100 | 44 |
| $T_2$ | 72 | 97 | 25 | 57 | 122 | 67 |
| $T_3$ | 115 | 120 | 27 | 56 | 78 | 70 |
| $T_4$ | 99 | 135 | 26 | 61 | 95 | 101 |
| $T_5$ | 76 | 88 | 26.6 | 60 | 120 | 122 |
| $T_6$ | 105 | 102 | 25.6 | 53 | 85 | 103 |
| $T_7$ | 115 | 140 | 28.0 | 58 | 135 | 93 |

**Table 8:** Micronutrient content (ppm) of spinach in first and second cuts.

| Treatments | Fe | | Mn | | Zn | |
|---|---|---|---|---|---|---|
| | F.C. | S.C. | F.C. | S.C. | F.C. | S.C |
| $T_1$ | 133 | 274 | 22 | 28 | 100 | 94 |
| $T_2$ | 156 | 225 | 26 | 43 | 128 | 105 |
| $T_3$ | 93 | 180 | 27 | 36 | 101 | 96 |
| $T_4$ | 150 | 168 | 36 | 42 | 142 | 116 |
| $T_5$ | 163 | 142 | 36 | 44 | 98 | 83 |
| $T_6$ | 181 | 191 | 43 | 33 | 132 | 84 |
| $T_7$ | 105 | 175 | 30 | 31 | 120 | 99 |

**Table 9:** Fe, Mn, Zn uptake (mg/pot) in the spinach plant.

| Treatments | Fe | | Mn | | Zn | |
|---|---|---|---|---|---|---|
| | F.C. | S.C. | F.C. | S.C. | F.C. | S.C |
| $T_1$ | 1.3 | 5.2 | 0.2 | 0.5 | 0.97 | 1.8 |
| $T_2$ | 1.5 | 3.6 | 0.24 | 0.68 | 1.20 | 1.68 |
| $T_3$ | 1.0 | 3.2 | 0.28 | 0.65 | 1.04 | 1.73 |
| $T_4$ | 1.7 | 3.3 | 0.4 | 0.82 | 1.6 | 2.27 |
| $T_5$ | 1.9 | 2.7 | 0.43 | 0.84 | 1.17 | 1.6 |
| $T_6$ | 1.8 | 3.5 | 0.43 | 0.6 | 1.32 | 1.53 |
| $T_7$ | 1.1 | 3.56 | 1.08 | 0.64 | 1.38 | 1.45 |

**Table 10:** Fe, Mn, Zn uptake (mg/pot ) in barley plants.

| Treatments | Fe | | Mn | | Zn | |
|---|---|---|---|---|---|---|
| | F.C. | S.C. | F.C. | S.C. | F.C. | S.C |
| $T_1$ | 2.07 | 2.9 | 0.304 | 1.22 | 1.9 | 0.92 |
| $T_2$ | 1.15 | 4.0 | 0.400 | 1.14 | 1.95 | 1.34 |
| $T_3$ | 2.07 | 3.2 | 0.49 | 1.12 | 1.34 | 1.26 |
| $T_4$ | 1.98 | 3.7 | 0.52 | 1.34 | 1.9 | 2.22 |
| $T_5$ | 1.66 | 3.3 | 0.56 | 1.38 | 2.52 | 2.68 |
| $T_6$ | 1.99 | 2.93 | 0.49 | 1.11 | 1.62 | 2.16 |
| $T_7$ | 2.53 | 3.36 | 0.62 | 1.39 | 2.97 | 2.23 |

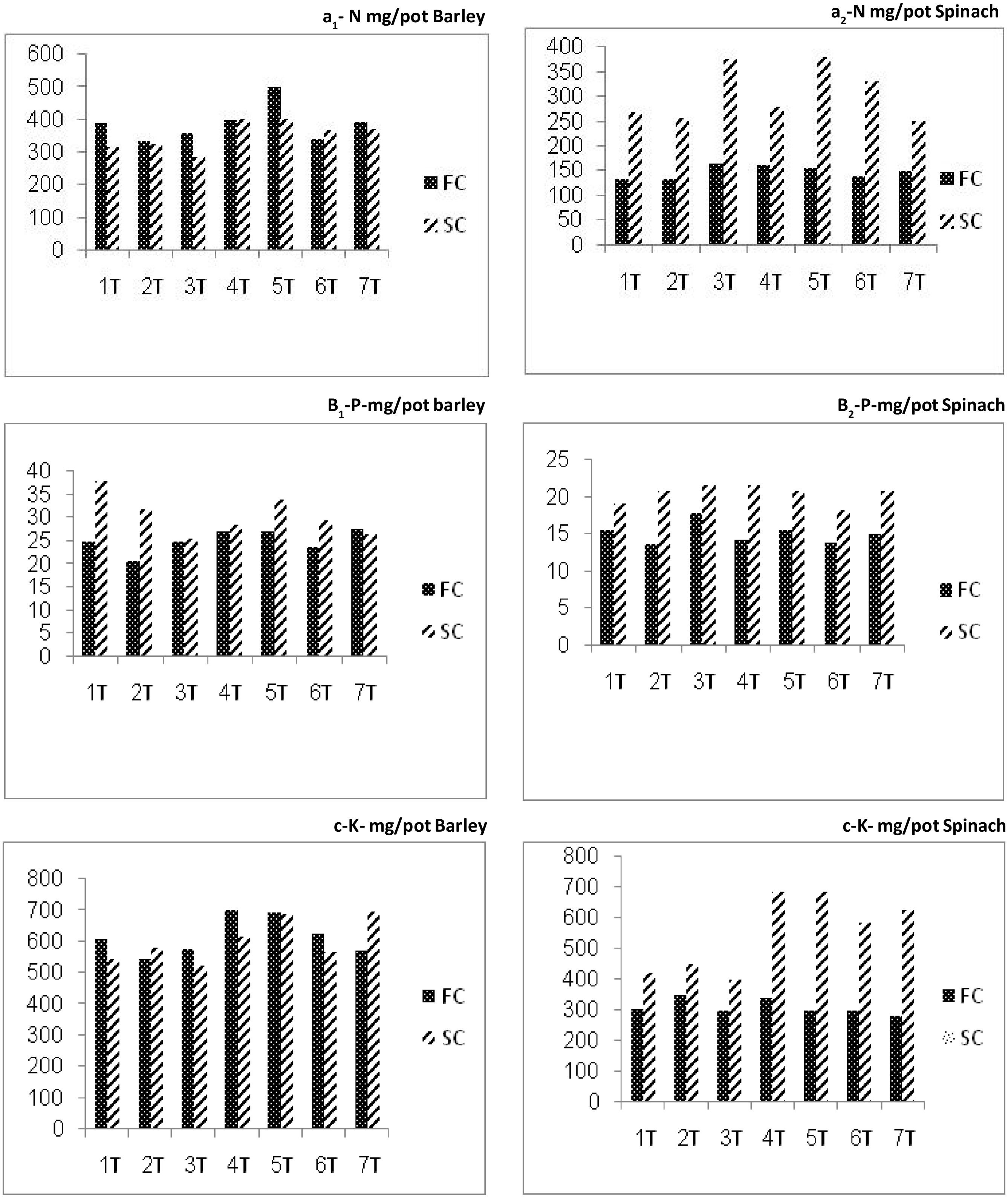


**Fig. 1:** Nitrogen, phosphorus and potassium uptake in barley and spinach plants under effect of different.

palvadirel *et al.,* 2014. These results indicated that, no significant difference in potassium concentration between first and second cuts in all treatments special when added the vinasse for barley or spinach plant. The highest value of k-uptake (644 and 540 mg/pot) with $T_7$ and $T_6$ for spinach plant. Vinasse effect on crop qualities and soil properties and it has high potential to substitute potassium and nitrogen nutrient to the present level of annual consumption.

This might increase the exchangeable $K^+$ and available K in soil caused by vinasse application and high concentration in vinasse make its application useful for soil agricultural after application of vinasse in soil with barley and spinach plants, there is no need to apply K fertilizer, which decreasing environmental pollution and increase farmers income imposed result to disposal of disposal of non-treated sugar industry effluents (Ze-Pujiang *et al.,* 2012) with high potassium content in vinasse, it is applied to meet out the 100% potassium content requirement of wheat crop Egypt (Arafat and Yassen, 2002).

**Phosphorous concentration**

In barley and spinach plant uptake as shown in table 3, 4 and fig. 3. phosphorous content in the barley plant higher than spinach plant and also the P contents in the second cut are lower than the first cut with spinach plant, the pronounced increase in P was observed with $T_1$ (100% NPK) and $T_3$ (vinasse + PK) in barley and spinach plants especially in the first cut, this values are 0.131 and 0.139% for barley and 0.16 and 0.173% for spinach. This results could be explained by the fact that the amount of inorganic P added within vinasse to soil insufficient to meet the required for barley and spinach yield in the second cuts. While vinasse application to the soil supplied the plant by part of required P not all required, there is must need to apply P fertilizer because vinasse has high levels of potassium, calcium and organic matter in its chemical composition as well moderate amounts of nitrogen and phosphorus and other nutrients (Garci, 1994) and once again Gemtos *et al.,* (1999) came out with recommendation to central part of Greece that vinasse by 7t/ha for every 4 years can substitute for N requirement of wheat crops and given the significant yield increase over the farmer practices.

**Micronutrients (Fe-Mn-Zn) concentration and uptake**

The mean values of nutrients Fe, Mn and Zn concentration (ppm) and uptake (mg/pot) by corps are shown in tables 7 and 8. In general, Fe and Mn concentration and uptake increased in the second cut compared with the first cut to barley and spinach plants, also there were difference between barley and spinach plant in micronutrient concentration and uptake especially in Fe and Mn, Fe-spinach showed higher concentration than barley, also Mn content and uptake in barley higher than spinach plant. The application of vinasse has noticeable effects on Fe-Mn-Zn phosphorus, sulphur and micro nutrient to crops (Rajavadire *et al.,* 2014).

Then mean value concentration of Mn ranged from 16 ppm for $T_1$ (control) and 4 ppm for $T_2$ in first cut of barley plant, and 33ppm for $T_6$ of spanish plant and 60 ppm for $T_{5-}$ of barley plant in second cuts, also, the mean values of Zn concentrations ranged between 98 for $T_5$ and 142 for $T_4$ in first cuts of spinach plant and 83 to 116 ppm is the second cuts, while in barley plant the concentration of Zn ranged between 78 for $T_3$ to 135 ppm for $T_7$ in the first cut. The micronutrient uptake increased parallel to dry matted increased.

Madejon *et al.,* (2003) shown that co-composting of vinasse with agricultural reduces serves two objectives, disposal of wastes and recycling of waste components, furthermore, vinasse composts can be used as an alternative to mineral fertilizers than spinach plants but Zn content and uptake was similar in two crops.

The highest means values of Fe content and uptake were found in crops treated with vinasse. Means Fe concentration averaged over all treatments and two plants was 105 ppm for $T_{7-}$and 225 ppm for $T_2$ in spinach plant. Early studied showed that vinasse has high potential to substitute potassium and nitrogen nutrients to the present level of annual consumption. It also contributes a substantial amount.

## References


Ao, J.H., H.H. Deng, Q.W. Li, Z.R. Huang and Y. Jiang (2009). Effects of vinasse on the properties of soil. *Guangdong Agricultural Sciences*, **7:** 177–180.

Arafat, S. and A.E. Yassen (2002). Agronomic evaluation of fertilizing efficiency of vinasse, 17th World cong. *Soil Sci. Symp.*, **14:** 1-6.

Chidankumar, C.S, S. Chandraju, N. Nagendraswamy (2009). Impact of Distillery Spent washes Irrigation on the Yields of Top Vegetables (Creepers). *World Appl. Sci. J.*, **6(9):** 1270-1273.

Christofoletti, C.A.1., J.P. Escher, J.E. Correia, J.F. Marinho and C.S. Fontanetti (2013). Sugarcane vinasse: environmental implications of its use. *Waste Manag,* **33(12):** 2752-61.

Cottenie, A., M. Verlo, L. Kjekens and R. Camerlynch (1982). Chemical analysis of plant and soils. Laboratory of Analytical and Agrochemistry, State University of Gent, Belgium. Article No. 42, 80-284.Wiedenhoeft A C (2006). Plant Nutrition Chelsea House Publi. USA.

Debruck, J. and W. Lewiski (1985). Epandage des effect concentration de la filiere detterave-sucre.les dernierees experimentations en R.F.A French translation from a German prototype.

Decloux M., A. Bories, R. Lewandowski, C. Fargues, A. Mersad and M. Lameloise, F. Bonnet, B. Dherbecourt and L. Nieto (2002). Interest of electro dialysis to reduce potassium level in vinasse-preliminary experiments. *Desalination*, **146:** 393-398.

Doelsch, E., A. Masion, P. Cazevieille and N. Condom (2009). Spectroscopic characterization of organic matter of a soil and vinasse mixture duringaerobic or anaerobic incubation. *Waste Manag*, **29:**1929–19

Duke, J.A. (1983). Handbook of Energy Crops. New CROPS Universityhttp://www.hort.purdue.edu/newcrop/duke_energy/dukeindex.html.

Freire, W.J. and L.A. Cortez (2000). Sugarcane vinasse. Agropecuária, Guaíba (in Portuguese).

Garcý´a, A. (1994). Efecto de la concentracio ´n de electrolitos en el aguade riego, sobre la recuperacio ´n de suelos so´dicos. Uso devinazas. *Suelos Ecuatoriales*, **24:** 80-83.

Gemtos, T.A., N. Chouliaras and S.T. Marakis (1999). Vinasse Rate, Time of Application and Compaction Elect on Soil Properties and Durum Wheat Crop. *J. Agroc. Eng. Res*., **73:** 283-296.

Gianchini, C.F. and M.V. Ferraz (2009). Benefits of using vinasse in planting land of sugar cane. Review Literature. evista Científica Eletrônica de Agronomia, 15.

Gloria, N. (1985). Environmental aspects in ethanol production relatedto vinasse disposal and groundwater, 31. Piracicaba: ESALQ.

Gopal, A. and D. Kammen (2009). Molasses for ethanol: the economic and environmental impacts of a new pathway for the lifecycle greenhouse gas analysis of sugarcane ethanol. *Environ. Res. Letters,* **4:** 1-5.

Hammad, S.A, M.A. Abou-Seeda, A.M. Ghamry and E.M. Selim (2007). Nitrate accumulation in Spinach plants by using N-fertilizer Types in Alluvial soil. *Journal of Applied Science Research*, **3(7):** 511-518.

Helm, J.H. and D.F. Salmon (2002). Cereal silage options for Western Canada. Proceedings of Western Canadian Dairy Seminar, University of Alberta, Canada, http://www.wcds.ca/proc/2002/.

Komdorfer, G.H. and D.L. Anderson (1993). Use and impact of sugar-alcohol residues vinasse and filter on sugarcane production in brazil, In Proc. of Inter American Seminor 122. Miami, USA, 15-17 September pp. 164-170.

Laime, E.M., P.D. Fernandes, D. Oliveira and E.A. Freire (2011). Technological possibilities for the disposal of vinasse: a review. *Revista Trópica–Ciências Agrárias e Biológicas,* **5**: 16–29.

Li, Y.R., Q.Z. Zhu and W.Z. Wang (2008). Multiple locations experiment of technique system for direct rational application of vinasse from cane mill in sugarcane fields. Southwest China. *Journal of Agricultural Sciences*, **21(3):** 749–756.

Madejón, P., J.M. Murillo, T. Marañón, F. Cabrera and M.A. Soriano (2003). Trace element and nutrient accumulation in sunflower plants two years after the Aznalcóllar mine spill. *Science of the Total Environment*, **307:** 239–257.

Martin-Olmedo, P., F. Cabrera, R. Lopez and M. Murillo (1996). Residual effects of sugar beet vinasse on plant growth. C. Rodriguez-Barrueco (ed.). *Fertilizers and Environment,* 527-531. © 1996 Kluwer Academic Publishers.

McLellan (2011. Barley production in Alberta: Harvesting: Whole plant barley silage. Government of Alberta, Agriculture and Rural Developement,Canada http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop1256.

Meng, Y.C., Q.Z. Tang, Z. Liu, G.F. Chen and Y. Wang (2009). Impact of several organic materials of sugar industry on soil microbe population in sugarcane field. Southwest China. *Journal of Agricultural Sciences*, **22(2):** 389–392.

Mo, Y.C., Y.P. Ye, Q. Liang and Y.R. Li (2009). Effects of vinasse on the quality of sugarcane and key enzymes in sucrose synthesis. Southwest China. *Journal of Agricultural Sciences*, **22(1):** 55–59

Murillo, J.M., F. Cabrera and R. Lopez (1993). Effect of beet vinasse on Germination and seedling performance of ryegrass (*Latium multifiarum*). *J. Sci. Food Agric.*, **61:** 155-160.

Obonoa, F., A.N. Nsangou, D.N. Tchawoud and C. Kapseue (2016). Valuation of Vinasse as Organic Fertilizer on the Corn Field American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) ISSN (Print) 2313-4410, ISSN (Online) 2313-4402.

Prasad, M.N.V. (1995). Cadmium toxicity and tolerance in vascular plants. *Environmental Experimental Botany*, **35:** 525–545.

Rajagonpal, V., P.S. Minhas, P.S. Kumar, Y. Singh, D.V.K. Nageshwar Rao and A. Nirmale (2014). Significane of vinasse waste management in agriculture and environmental quality- Review. *African Journal of Agriculture Research*, **9(38)**, 2862- 2873.

Soobadar, A, N.G. Rene and K.F. KeeKwong (2012). Impact of High Rates of Vinasse on Some Pertinent Soil Characteristics and on Sugarcane Yield in Mauritius. *J. Sustain. Agric*., **36(1):**36-53.http://dx.doi.org/10.1080/10440046.2011.620226

You, Q., T.M. Su and Y. Zhong (2009). Effects of vinasse on sugarcane field. *Guangxi Agricultural Sciences*, **40(6):** 677–680.

Ze-Pu, Jiang., Y.R. Li., G.P. Wei., Q. Liao., T.M. Su, Y.C. Meng, H.Y. Zhang and C.Y. Lu (2012). Effect of long- term vinasse application on physic-chemical properties of sugarcane filed soils. suger tech., 412–417

Zhou, M.Q., Y.H. Luo, Z.B. Zhou, D.Y. Gong and X. Zhou (2008). The effect of alcohol waste liquid (as a top dressing) on growth and yield of sugarcane. *Guizhou Agricultural Sciences*, **36(6):** 102–103.

Zhou, Z.B., Y.H. Luo, M.Q. Zhou, D.Y. Gong and X. Zhou (2009). Effects of alcohol wastewater (as basal manure or dressing) from the sugar refinery on growth and economic benefit of sugarcane. *Guizhou Agricultural Sciences*, **37(6):** 66–68.