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Plant Origin Wastes as Soil Conditioner and Organic Fertilizer: A Review

[1]*Md Zahangir Hossain,* [2]*Peter von Fragstein und Niemsdorff and* [3]*Jürgen Heß*

[1]Agrotechnology Discipline, Khulna University, Khulna-9208, Bangladesh
[2]Department of Organic Vegetable Production, University of Kassel, Germany
[3]Department of Organic Farming and Cropping, University of Kassel, Germany

Abstract: Use of by-products in agriculture plays a great role in recycling essential plant nutrients, sustain soil security as well as protect the environment from unwanted hazards. They also reduce toxicity of some heavy metals resulting increase yield of crops. This review paper deals with the use of transformed plant by-products as soil conditioner and fertilizer in agricultural field. Pressmud and molasses contain different nutrients and can be substituted for phosphatic and potassic fertilizers, respectively, in crop production. It can restore degraded soil, stabilizing soil particles and in waterlogged soils filter cake increases availability of nutrients. Vinasse can be used as fertigation and creates nutrients reservoir in winter season. It increases pH, CEC value in soil and availability of P and K for agricultural crops. Direct application of olive mill wastewater increases porosity, aggregate stability and reduces soil erosion and run-off of sloppy lands. It increases C/N ratio and helps to slow release of N into the soils. Plant origin wastes can be used as soil conditioner and fertilizer in agriculture. However, for maintaining soil health and crops yield, it is necessary to determine the proper doses of these by-products to avoid negative impact on soil, environment as well as human health.

Key words: By-products · Pressmud · Olive mill wastewater · Nutrients · Crop production

INTRODUCTION

According to Hoornweg and Bhada-Tata [1], waste generated from the consumer-based lifestyles of world people. It includes the items are no longer used by people, intend to discard or have already thrown away and some are require to discard. For example; household rubbish, sewage sludge, wastes from manufacturing activities, packaging items, discarded cars, garden waste etc. Therefore, a large variety of different wastes producing from all our daily activities of life [2]. Waste generation rates will more than double over the next twenty years in lower income countries [1]. These ever growing large amounts of wastes create environment and public health problems as well as odours from the landfills. Therefore, to minimize these problems reuse as soil conditioner as well as fertilizers in agriculture could be a better solution of these plant origin wastes. Nowadays, with increasing demand to conserve natural resources, recycling of wastes assumes major importance. The organic waste of plant origin provides a good source of nutrients to improve soil productivity [3]. Application of organic wastes, to agricultural soils is popular cultural practice due to the observed improvement of soil properties and thus increases in crop yield and quality [4, 5]. Pressmud (PM) is a solid organic waste of sugar industries, serve as good organic manure and an alternative source of plant nutrients and soil conditioner [6]. PM is considered as a carbon source [7] and contributed to increase yield of crops and CEC in soil [6]. Like PM, another by-product of sugar producing crops is called molasses [8]. Usually, it is used in production of ethanol [9], but molasses is a good source of plant nutrients [10], similarly, vinasse (semi-liquid waste of sugar-alcohol industry) contributes to improvements in soil quality and productivity of agricultural crops [11]. According to Barbera *et al.* [12], the olive mill wastewaters (OMWs) are considered as a good source of nutrients and their use for agricultural purposes may be a low cost source for water and nutrients. Thus, the reuse of OMWs [13, 14] is potentially useful, especially in the regions of characterized by serious water and soil organic matter deficiencies. The objective of this review is to evaluate the potential for the use of plant origin by-products as soil conditioner and organic fertilizer in agriculture.

Corresponding Author: Md Zahangir Hossain, Agrotechnology Discipline, Khulna University, Khulna-9208, Bangladesh.
Cell: +8801715640353, Fax: +88041731244.

Pressmud: Pressmud is a solid waste, generated from sugar industries [15]. It is also called PM cake or filter cake [16]. Like some useful chemicals, PM is utilized as fertilizer in several countries, such as Brazil, India, Australia, Cuba, Pakistan, Taiwan, South Africa and Argentina [11]. It has some good advantages (low price, slower release of nutrients, consist of trace element, high water holding capacity and mulching properties) as using for soil application [17]. It contains many plant nutrients [11] and maintain plant health [18], restore the degraded soils [19] and it is also used as soil reclaimant [20] and conditioner [11]. Therefore, it is supposed to be of various uses in agriculture [21]. From the following discussion we will prove that it can be used in agriculture as soil conditioner as well as fertilizer.

Soil Conditioner: PM has a great influence on soil physical, chemical and biological properties that will be discussed in the following ways.

Physical Properties: Due to high organic matter (OM) content [20] PM is used for various purposes such as, improving the tilth, helps in granulation, stabilize soil particles, degree of aeration, water filtration [19], drainage [20] and water holding capacity of the soil [17]. For example, it has been investigated that application of 154 to 174 t PM ha^{-1} improves tilth condition of soil. In eroded soil, PM plays a great role to improve pore size distribution of soil, moisture retention capacity and prevents soil compaction for deeper penetration of plant roots into the soil [19]. Moreover, Saleh-e-In *et al.* [20] reported that it maintain soil stability through prevents soil erosion, crusting and cracking of soil. Guong *et al.* [22] stated that incorporation of PM compost with *Trichoderma* spp. and fresh *Tithonia diversifolia* increase soil aggregate stability and reduce soil compaction.

Chemical Properties: PM improves soil fertility [19] and soil health [23] as well as increase yield of crops [24]. PM of sulphitation is used for reclamation of alkali soils whereas that of carbonation is useful to amend acidic soils [17]. It slightly adjusts soil pH [20] and also increases the availability of some pant nutrients. PM plays a great role as ameliorate of salt affected soils. For example, in Lousiana, USA, incorporation of PM 80 t ha^{-1} increased macro-nutrients, OM content, decreased EC and sodium adsorption ratio [24]. Similarly, Guong *et al*. [22] stated that incorporation of PM compost with *Trichoderma* spp. and fresh *Tithonia diversifolia* increase soil OM, nutrients, CEC, base saturation etc. [19] described that PM helps to increase of organic carbon in soil. P and K content also increase in sandy soils due to application of PM. the authors stated that PM addition to soil has considerable influence on the micronutrient composition as well. As for example, after the PM application iron content did not increase, however, the availability of Al was decreased below toxic level.

Biological Properties: PM stimulates normal microbial growth [20] and it can be considered as a vital source of carrier material for microbial [25] and leguminous [17, 26] inoculants. Solaimalai *et al.* [19] described that due to application PM contributes to increase a remarkable in the number of non-spore forming bacteria and also different types of fungi including *Neurospora crassa, Trichoderma viride, Aspergillus sp.* and *Peniciuium sp.* but a few pathogenic fungi such as *Fusarium* and *Pythium* are absent. Yang *et al.* [23] stated that addition of PM the populations of fungi, bacteria and actinomycetes increased in soils. Application of PM increased microbial C and N than soils treated chemical fertilizer. It can also be used for controlling various nematodes and to protect the plants from various soil borne diseases [18].

As Fertilizer: According to Prado *et al.* [11], PM can partially substitute for mineral fertilizers and some suggestions have been made as to specific amounts to be applied in the cultivation of crops. For example, in Brazil, the recommended doses of filter cake for sugarcane crop, at pre-planting are 80–100 t ha^{-1} if applied to the whole area, 15–30 t ha^{-1} if applied in the planting grooves, or 40–50 t ha^{-1} if applied between the grooves. Incorporating PM into the soil has been proved successful in increasing the cane yield of sugarcane. It has been observed that yield of sugarcane is increased due to various levels of PM application [23, 27]. Application of PM 5-7 t ha^{-1} of soil resulted in considerably higher cane yield [19]. It was confirmed that the higher yield was found by integrated application of PM 10-20 t ha^{-1} and rice mill ash 10 t ha^{-1} along with 25-50% reduction of chemical fertilizers [28, 29]. The highest cane yield of 86.7 t/ha was recorded in the treatment 75% NPK + enriched PM with *Pleurotus* sp [30]. Addition of PM 15 t ha^{-1} along with 25% reduction of chemical fertilizers gave significant yield [27]. It is proved that highest cane yield was obtained by 50% N from PM with 50 % N through inorganic source [31].

In case of many field and horticultural crops, it has been proved that addition of PM yielded positive results [24, 32]. The yield of rainfed groundnut [19], lentil [33], citrus fruit was increased due to PM addition 10 t ha^{-1} and also increasing the availability of macro-nutrient in soil [19]. Dry matter yield of maize was increase 70% with the application of PM plus inorganic N source [32]. The higher number of branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1}, seed yield, dry-matter yield and root length of lentil were recorded in soil with PM addition at the rate of 10 ton ha^{-1} [33]. Yadvinder-Singh *et al.* [34] suggested that application of PM @ 5 t ha^{-1} increase the yield of rice (first crop) also increase in wheat (subsequent crop). In Pakistan, application of PM with the combination of FYM and humic acid the maximum total dry matter yield of sorghum, emergence m^{-2}, plant height were observed [24]. Application of PM @ 5 t ha^{-1} and inorganic P-fertilizer gave better results in different growth parameters of groundnut. Similarly, it increased the dry matter of maize crops. Moreover, PM application @ 20 t ha^{-1} increased yield of wheat (65.2%), greengram (20-30%) and also increased in blackgram and maize. Application of PM @ 10 t ha^{-1} with chemical N increased 33.1% grain yield over only chemical nitrogen in rice. Various horticultural crops like pomegranate, pineapple and turmeric were also reported to benefit from PM application. Seed inoculation with bioinoculants has also been proved along with PM application in crops [19].

Enhanced nutrient uptake in plants due to PM application was well established [18, 24]. It has been proved by incubation of soil at 30°C for 75 days that 20% of the nitrogen becomes available to crop from PM at 30 days after its application and is the maximum amount available at 60 days. On the other hand, the phosphorus becomes available immediately after its incorporation into soil [34]. From earlier investigations, it has been confirmed that application of PM nutrient uptake is increased by different crops, such as, blackgram (P), greengram (N, P and K), maize (N and Zn), sugarcane (N, P and K) and mustard (S) etc. In case of sugarcane, the N, P and K content and was also increased in the following year with the application of 25 t PM per ha. Addition of PM contributes to rise in calcium content in wheat and maize tissues. Whereas, in acid soils, the manganese content was decreased in root, shoot and grain of wheat and maize with increasing rate of PM [19].

Molasses: Molasses is the final effluent or by-product [8, 35], generated from sugarcane and from sugar beets [8]. Molasse contains total solids (83.2%), ash (10.5%), K (2.89%), Ca (0.54%), Na (0.28%) and it is acidic (5.6) in nature [10]. From the literature it has been proved that molasses can play a great role in agriculture as soil conditioner as well as fertilizer.

As Soil Conditioner and Fertilizer: Cleasby [36] reported that most of the sugar producing countries uses molasses as other purposes that are more profitable than fertilizers. However, remarkable amounts are still used in the field in Mauritius and Australia. From the investigation in these two and in other sugar producing countries, it may be concluded that where soils are deficient in potash and poor structure, the application of molasses is highly beneficial. The soils with high potash content and good physical properties, the response of the molasses's nitrogen appears to be equaled by the application of $(NH_4)_2SO_4$ or other forms of nitrogen. According toWynne and Meyer [37], molasses is used as a main source of potassium and it has also other significant advantages such as increasing OM content [36, 37] in the soil and microbial activity [37] associated with nitrification. Molasses also provides some primary and secondary elements in small quantities such as phosphorus, sulphur, calcium and magnesium, as well as supplies micronutrients for the plants [36, 37]. Molasses has beneficial effects on the structure of heavy clay soils with poor physical properties and it occurs due to the results of improving their tilth, brings about an increase in the number and stability of the soil aggregates [37] and reduces surface crusting in hard-setting soils. It has been proved that molasses has particular value on soils sensitive to both wet and dry conditions [36]. Molasses is also beneficial for reducing soil borne pathogen into the soil. It can control nematodes through certain species of fungi that are able to parasitize plant feeding nematodes [37] and act as a part of microbial agent for disease and pest control in leafy vegetable [38].

Vinasse (VS): Vinasse is the final concentrated by-product of the biomass distillation, mainly for the production of ethanol, from sugar crops [39], starch crops, or cellulosic material [40]. It contains different nutritive minerals such as, N (14.35), P (0.02), K (0.85) g L^{-1} and its pH is 5.76 [41]. Ample literatures have confirmed that VS can be used as soil amendments and fertilizer.

As Soil Conditioner: Osman [42] mentioned that both diluted and concentrated VS can be spreaded on agricultural fields. Proper utilization of VS contributes to improvements in soil quality and agricultural productivity as reported by Prado *et al.* [39]. Moreover, it provides favorable conditions for nitrogen assimilation into the soil, protects nutrients against washing out in winter and maintains them as reserve nutrients as a slow release during the vegetative period [42]. The use of VS can result in modifications in soil physical, chemical and biological properties.

Physical Properties: It has been reported that the addition of VS combined with OM can improve the physical conditions of the soil [40]. In China, Jiang *et al.* [43] studied the effects of VS application on physico-chemical properties of soil. From this study, the results showed that, after 2–3 years of continuous VS application to sugarcane fields, reduced the bulk density and clay content of soil, while the total porosity and capillary porosity of soil was increased. Moreover, it enhanced the soil water stable aggregate content in soil after application of VS in the field. Similarly, Prado *et al.* [39] also reported that addition of VS improved macro-aggregation of soil, increased OM content of soil in Spain. Addition of VS in Spain, the structural stability of soil increased 26.5% [5] and 10.5% [44] bulk density decreased 26.3% [5] and 13.5% [44] compared to the control. Similar trends were also observed by Tejada and Gonzalez [45]. In Brazil, after 2–3 years of continuous VS application, showed positive impact on the physical properties of the soil. However, addition of VS showed some negative effect on soil physical properties as reported by several authors. For example, Tejada and Gonzalez [45] evaluated higher level of VS (10, 20 and 40 t ha^{-1}) on wheat field, showed negative effect on bulk density and structural stability of soil. Addition of fresh VS showed detrimental effect of soil physical properties, such as, destabilized soil structure and increased soil loss as reported by Tejada and Gonzalez [4].

Chemical Properties: Zolin *et al.* [46] reported that the application of VS during years, increased the levels of organic carbon and potassium in soil. The addition of sugarcane VS in the soil increased pH [40, 47]. According to Christofoletti *et al.* [40], the sugarcane VS increases the availability of some ions and also increase CEC in soil [39]. However, In Egypt, addition of VS wastes caused a significant decrease in soil pH and significant increases in soil available P, total N and total organic C in durum wheat field [42]. Similar trend was also found by Jiang *et al.* [43]. In Spain, addition of VS proved that soil oxidizable-C, total humic extract-C and humic acids-C contents significantly increased in soils treated with composts when compared with control and inorganic fertiliser treatments [48]. Exchangeable Na percentage increased significantly in VS amended soils when compared with the others organic waste amended soils [44].

Biological Properties: According to Christofoletti *et al.* [40], the addition of VS influences the population of microorganisms in the soil and stimulating biological activities [47, 49]. Moreover, when VS was co-composted with a cotton gin crushed compost, the resulting compost had a positive effect on the soil's biological properties, such as; microbial biomass, soil respiration and dehydrogenase, urease, BBA-protease, â-glucosidase, phosphatase and arylsulfatase activities increased by 57.1%, 76.4%, 98.4%, 98.2%, 99.8%, 99.4%, 89.8% and 92.3%, respectively, with respect to the control soil. Similar results were also reported by Tejada *et al.* [44]. On the other hand, Tejada *et al* .[5] reported that beet VS had a negative impact in the biological properties of the soil, interfering with microbe biomass, respiration and enzymatic activities.

As Fertilizer

Seed Germination: It was estimated that germination of seed was inhibited with more than 50% of VS concentration [50]. It has been reported that the toxic effects of this effluent in the growth, biomass and primary productivity of *Pisum sativum* and *Helianthus annuus* [40]. Ramana *et al.* [51] studied seed germination (%), speed of germination, peak value and germination value of tomato, onion, bell pepper, pumpkin and cucumber seeds. The authors observed a decrease in the germination rate of seeds in these selected crops with the increase in the concentration of VS. However, Germination was inhibited in five of the crops examined in concentrations above 50%. In a pot experiment under greenhouse condition, application of VS was investigated with arrowleaf sida (*Sida rhombifolia*), Suriname grass (*Brachiaria decumbens*) and sugarcane. The study revealed that VS had negative effects on the emergence and development of seeds of the Suriname grass and arrowleaf sida, but not on sugarcane, possibly due to the sensitivity of seeds to alcohol compounds present in the effluent [40].

Growth and Yield of Crops: In China, YunChuan *et al.* [52] found that treated with VS has increased productivity and sucrose yields. Similarly, in Brazil, Paulino *et al.* [53]

and Zolin *et al.* [46] proved that the long-term application of VS (150 m^3 ha^{-1} $year^{-1}$) in sugar cane production had positive effects on productivity. It has been proved that wheat production increased by VS application in Greece [39]. In the same country, a study was conducted by Cremonez *et al.* [41] on evaluation of VS on golden linseed (*Linum usitatissimum*). The study confirmed that VS showed positive results on plant height, dry and fresh weight, capsules number and productivity of crops. In Egypt, Osman [42] examined the use of VS (2.5, 5 and 10%) as a partial replacement of mineral fertilizers on wheat (*Triticum aestivum* L., CV. Giza 168) in sandy soil. The author found that wheat yield was increased by increasing the rate of VS amendment.

Olive Mill Wastewater: OMW is a byproduct of olive oil production, red to black in colour [54] and it may be considered as an additive to enhance soil fertility [55] as described follows-

As Soil Conditioner

Physical Properties: According to Barbera *et al.* [56], the effects of spreading OMW on physical soil characteristics depend on many factors, such as, edaphic, climatic characteristics, the amount of OMW and the method of application. It has been suggested that these effects can be described in changes of soil porosity, aggregate stability and water retention and movement. It was found that the microporosity of the soil aggregates decreased during the first few weeks after OMW application and it increased significantly after one month of application. In earlier studies, it was observed that spreading of OMW for three consecutive years (at 640 m^3 ha^{-1} $year^{-1}$), only 0.5–50 × 10^{-3} mm of microporosity was increased and consequently >50 × 10^{-3} mm was reduced of the macroporosity in soil. In Syria, Mahmoud *et al.* [57] evaluated the long-term effects of OMW application on selected soil hydraulic properties and confirmed that the drainable porosity decreased in studies conducted for 5 and 15 years as a result of increasing soil organic matter concentrations. Usually, incorporation of OMW creates the enhancement of porosity in opposite direction [56]. From the previous studies, it revealed that spreading of OMW at high doses (160 m^3 ha^{-1}) the micropores significantly increased after 20 days of OMW application and then it decreased after 4 months in OMW treated soil. Due to the cementing action of organic polymers, such as, polysaccharides in OMWs resulted the short term increased in structural stability of soil. In Jordan, it confirmed that the hydraulic conductivity of saturated soils generally decreases after irrigation with waste waters [58]. Mahmoud *et al.* [57] reported hydraulic conductivity decreased in horizons less than 60 cm in a continuous application of OMWs to an olive grove for 5 and 15 consecutive years. It was positively correlated with decreased drainable soil porosity.

Chemical Properties: Several authors reported that OMW application showed slight changes in pH of soil [59, 60, 61]. These small pH variations (4.9 to 5.77) were temporary [62] and similar trends also found by Chartzoulakis *et al.* [63] for consecutive several years. In Italy, Serio *et al.* [64] studied on chemical and biological properties of soil and found a small increase (6.4 to 6.9) in pH from 20 to 40 cm depth of soil. Generally, addition of OMWs increases EC in soil due to containing high salt concentrations. Serio *et al.* [64] evaluated the physico-chemical and microbiological characteristics in soil of a 16 years old olive orchard and observed that soil EC increased at a depth of between 0 and 20 cm and it continued more than to 2 months. In Syria, it was found that after spreading of OMW over the same soil type (cambisol) for 5 and 15 years, the OM increased to 22.7 and 36.8 g kg^{-1}, respectively within 30 cm of the top soil [57]. From a laboratory experiment of Aguilar [65] proved that NH_4^+ and NO_3^- were complexed with diluted OMW. Several authors reported an increase in P and K [59, 61, 66] with applying of OMWs in soil. In Greece, Chartzoulakis *et al.* [63] stated that application of OMW at the rate of 80 m^3 ha^{-1} provides 16, 17 and 208 kg of N, P and K, respectively.

Biological Properties: In Israel, Saadi *et al.* [67] worked on the short-term effects of OMW on soil microbial activity in a vertisol soil and found that the significant higher numbers of microorganisms than the control a week after the last application. Similarly, Mechri *et al.* [59] observed that the ratio of fungi to bacteria significantly increased from 0.23 in the control to 1.11 in the soil that was amended with 150 m^3 ha^{-1} of OMW. Changes in bacterial communities were observed by [68] as consequence of OMW application in the soil of Greece. Moreover, Mekki *et al.* [60] observed a quantitative increase in soil microflora, particularly in the total aerobic heterotrophic bacteria. After spreading 80 and 160 m^3 ha^{-1} of OMWs on a sandy soil, Chartzoulakis *et al.* [64] reported an increase in soil microbial biomass, such as, the soil denitrifying community, fungi and actinomycetes. In Morocco, Hassani *et al.* [69] investigated OMW as an organic amendment for *Mentha spicata* L. and found that increase in the populations of yeast, actinomycetes and cellulolytic bacteria at 80 m^3 ha^{-1} of OMW. However, Mekki *et al.* [70] described that the fungal number was decreased when OMW applied at more than 50 m^3 ha^{-1}. Some basidiomycete communities, such as, *Cryptococcus* yeasts and *Ceratobasidium* spp. dominated in the soils treated with OMW [71]. Piotrowska *et al.* [62] examined the short-term effect of OMW on chemical and biochemical properties of a soil and found that increased activities of dehydrogenase, fluorescein diacetate hydrolase and urease and decreased activities of nitrate reductase and phosphatase enzyme in soil. On the other hand, Mekki *et al.* [60] found that the OMWs that contain more Na (0.94 g L^{-1}), was responsible for decreasing the urease and ammonia oxidase activities in treated soil [56].

Control of Phytopathogens: Barbera *et al.* [56] reported that OMWs have been evaluated for the control of phytopathogenic soil agents due to containing of polyphenols. In Greece, Kotsou *et al.* [72] observed that OMW is effective against *Rhizoctonia solani,* causal organism of damping-off disease of lettuce crop. [73] also found positive results against *Rhizoctonia solani* and *Fusarium solani*. Some basidiomycete communities, such as, *Thanatephorus cucumeris* and *Athelia rolfsii* were suppressed by OMW application in soil as reported by Karpouzas *et al.* [71]. In addition, positive effects were reported for the control of *Verticillium dahliae* [74]. In Tunisia, Debo *et al.* [75] demonstrated the effectiveness of hydroxytyrosol preparation for controlling olive psyllid (*Euphyllura olivina*).

As Fertilizer: According toAltieri and Esposito [76], OMW has beneficial effects on growth and yield of several crops, such as, maize, lettuce, spinach, wheat and tomato both in field and pot experiments. Addition of digested OMW increased about 51% more yield of wheat than control soil and other yield contributing characters (the no. of kernels $area^{-1}$, spike density and kernel weight) were also increased [77]. In Morocco, application of OMW at 8 L m^{-2} showed a positive effect on *Mentha spicata* L. as reported by Hassani *et al.* [69]. The authors found that a significant increase shoots weight (94%), shoots size (15%), number of floral spikes (145%), stolons weight (60%) and stolons size (51%). In addition, the essential oil yield was also significantly increased more 17% over the control Gamba *et al.* [78] described that application (160 m^3 ha^{-1}) of OMW yield of alfalfa was slightly increased over the control. In Italy, Montemurro *et al.* [66] examined the yields of ryegrass, proteic pea and clover with application of OMW at 0, 80 and 120 m^3 ha^{-1} in a three years experiment. The results revealed that yield of ryegrass increased 40% and 41.6% compared to control for 80 and 120 m^3 ha^{-1} respectively, while 27% more yield was found at the lowest level of OMW in proteic pea. Whereas, clover yield was decreased, but the protein content increased 26.3% and 28.7% for both level, respectively over control.

CONCLUSION

Generally, in the line of sustainable agricultural production along with preserving the environment, it is necessary to recycle the wastes or by-product from plant origin. The wastes can be used as soil conditioner as well as fertilizers for agricultural production. For this purpose, a few are used as directly and most of them need to digest or decompose to avoid environmental and human health hazards. From the literatures, it is confirmed that compost is the most common technology to recycle and to dispose them easily in a safe way. Composted wastes used as organic fertilizer can supply essential plant nutrients, improve physical, chemical and biological properties of soil, reduce toxicity of some heavy metals such as, Cr, Cd, Al, Pb etc. thus resulting increase yield of agricultural crops.

PM or filter cake has a great potential for agricultural use as soil conditioner and fertilizer in different sugar producing countries of the world. PM has been utilized with positive results and it can be substituted for phosphate mineral fertilizers in field crop production by composting and vermicomposting technology. It is very much useful for the production of seedlings. PM has some advantages like low price, slow release of nutrients and mulching properties. It can improve soil properties by restoring the degraded soil, stabilizing soil particles. Especially in waterlogged soils filter cake increase availability of nutrients for plants by increasing the pH in soil. Literature review confirms that it manage some phyto-pathogenic microogranisms such as, *Fusarium* and *Pythium* etc. Including some limitations it has a great role in agricultural production of crops. Like other many plant originated by-products, molasses can be used as fertilizers, especially in potassium deficient with poor structured soil. It provides organic matter and some other nutrients for crops. It improves soil aggregates and increase microbial activity in soil. Based on literature review, it appears that it can control plant parasitic nematode, soil borne pathogen and thus prevent plants from various diseases. Similar to molasses, vinasse can be used as fertilizer with irrigation and thus reduce the cost of fertilizers. It improves soil quality by making suitable environment for N assimilation in soil, creates nutrients reservoir in winter season to slow release for crops. VS increases pH, CEC value in soil and availability of P and K for agricultural crops. It favours the microbial populations, especially for fungi and some filamentous bacteria. Yield of various crops were increased with addition of VS in the field as confirmed by several authors. However, VS has some inhibitory effect on seed germination with higher (>50%) doses. The direct application of OMW increases porosity aggregate stability in soils, resulting reduces soil erosion and run-off of sloppy lands. It increases C/N ratio and helps to slow release of N into the soils. However, OMW contains some and exchangeable cations that hamper infiltration rate and increase salinity in soil. From this review it may be concluded that plant by-products can be used as soil conditioner and fertilizers in agriculture. However, for maintaining soil health crops yields it is necessary to determine the proper doses of these by-products to avoid negative impact on soil, environment as well as human health.

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