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# Use of press mud for sugarcane farming and sustaining soil health

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## Abstract

Sugarcane industries are age-old industrial practices which contribute a significant amount of press mud as waste. Handling and management of this by-product is huge task, because it requires lot of space for storage. However, it provides opportunity to utilize in crop production as organic nutrient source. Application of press mud to soil improves the soil chemical, physical, and biological properties and enhanced the crop quality and yield. A huge possibility of press mud can be used in agriculture to cut down the chemical fertilizer requirement, which helps in saving of costly chemical fertilizers.

**Keywords:** Press mud, sugarcane, soil health, Nutrient

## Introduction

Sugarcane is one of the world's largest crops. It is cultivated on about 26.9 million hectares (M ha), in more than 109 countries, with a worldwide harvest of 1.91 billion tonnes. Sugarcane is a long-duration exhaustive cash crop. It requires larger amounts of macro as well as micro nutrients. It has been measured that sugarcane of 100 t that produced from 1 ha land removes 140, 34 and 332 kg NPK $ha^{-1}$, respectively, from soil (Bokhtiar *et al.* 2001). High requirement of nutrient limits the yield due to scarcity of fertilizers. Similarly, spiralling prices coupled with a short availability of fertilizers in peak season cause depletion of nutrients from the soil. Brazil is a large producer of sugarcane in the world. The next five major producers are India, China, Thailand, Pakistan, and Mexico. The sugar industry is the second largest agricultural industry in the country after the textile industry. Its importance in day-to-day life adds its value. The world demand for sugar is the primary driver of sugarcane cultivation. Sugarcane accounts for 80 % of sugar produced; the rest is made from sugar beets. New innovations and accelerated mechanization enhanced the sugarcane productivity in a quantum jump. In India, many industries are consuming agricultural produce as their raw material and generate wastes. Sugarcane

industries generating huge amount of press mud which are creating the storage problem. There is a growing concern for its safe disposal without compromising the ecosystem.

## Sugarcane products

Sugarcane products like (a) Food: sucrose, fructose, syrups, and jiggery; (b) Fiber: cellulitic materials; (c) Fodder: green leaves, top portion; (d) Fuel: residue/waste materials; (e) Chemicals: alcohol, bagasse, and press mud. All products are very important, but here, it is mainly focused on sugarcane press mud and their economic value in crop production. Press mud or filter cake, is generated as a by-product of sugarcane industries and characterized as a soft, spongy, amorphous, and dark brown to brownish materials. It is generated during the purification of sugar by carbonation or sulphitation process. Both the processes separated clear juice on top and mud at the bottom. In general, when 100 t of sugarcane is crushed, about 3 t of press mud are produced as a by-product (Gupta *et al*. 2011). It is considered as rejected waste material of sugarcane industries that cause problem of storage and pollution to surrounding of sugar mills on its accumulation. It contains sugar enhanced its decomposition in soil. Press mud supplies a good amount of organic manure and can be an alternate source of plant nutrient and act as a soil ameliorates. The amount of sugar press mud (SPM) production depends upon the carbonation and sulphitation process; it is 7–9 and 3–5 % of the total weight of sugar cane from above the process, respectively. It contents 50–70 % moisture, which is most favourable for soil micro-organisms, especially earthworms. The composition of SPM is also affected by variety, fertility status of soil, and also the recovery process of industries. It contains significant amounts of iron, manganese, calcium, magnesium, silicon, and phosphorus, and enhanced the suitability of SPM as a source of nutrient. Press mud, an end product of the sugar industry, is used as one of the substrates in bio-composting. The SPM is also generated from the alcohol distillation originating from the fermentation of sugarcane molasses; it contains a huge volume of water and plant nutrients. Therefore, it is a necessity of treating SPM to a valuable bio-fertilizer for agricultural crop production. The integrated use of SPM with nitrogen fertilizers has enhanced the dry matter, cane, and sugar yield. It is reported that use of press mud with urea in the 1:1 ratio increased the number of millable cane and yield of sugarcane. Due to application of press mud, the availability of macro- and micro-nutrients in soil increases. It also supplies carbon-to-soil micro-organism, which helps during decomposition and nutrient transformation reactions. Application of press mud along with inorganic fertilizers resulted higher cane yield. Therefore, recycling press mud into agriculture land seems to be a good option, to

sort out the waste storage problem and shortage of plant nutrient. Application of 25 t $ha^{-1}$ SPM significantly improved sugarcane yield and yield attributes. Application of press mud improved the physical condition of soil by reducing bulk density and enhanced macro-spore for a better root growth, and ultimate enhanced the cane yield. Application of filter cake increase soil CEC and residual effects remained after 4 years. Press mud contains 21 % organic carbon along with macro- and micro-nutrients, which promote microbe's growth, improve cation exchange capacity (CEC), and nutrient supply in the soil. Incorporation of press mud in field enhanced the soil quality parameters and sugarcane yield and cane juice quality. The press mud reported as a valuable plant nutrient and may affect physical, chemical, and biological properties of soil. Application of press mud in sugarcane cultivation is attributed in various growth and yield parameters, such as weight and number of millable cane at harvest. The continuous land application of SPM for crop production, build up a significant amount of organic carbon in soil and in 5–6 years is likely to improve soil health by adding sulfur (S) and organic matter to soil. Land application of press mud should become a common farm practice. The press mud Constituents (%) are as Moisture, 50-65; Fiber, 20-30; Crude wax, 7-15, Sugar, 5-12.

## Availability of press mud in India

The more than 600 sugar factories are in the country and estimated that the production would go up to 26 Mt. At the same time, annual by-product production through these industries is more than 8 Mt of press mud. Government of India has solved the problem of disposal of press mud that can be used for compost making.

## Use of press mud for sugarcane production

Press mud having a significant amount of nitrogen and phosphorus, and easily decomposable sugar content. Apart from nutrients, its C:N ratio is wider, that creating immobilization, which can be remedied by application of inorganic fertilizers. The use and impact of filter cake for sugarcane production on plant cane increased sugarcane yield without detrimental effects on cane quality or the environment.

## Effect of organic residue application on nitrate production

The residue with wide C:N ratio initially immobilizes nitrogen from the soil and releases nitrate later when mineralization sets in. The nitrogen (N) mineralization of press mud increased with increase in the incubation period. The N mineralization potential differed markedly depending upon organic

material and soil type. It ranged from 52 to 107 mg $kg^{-1}$ for press mud. Press mud acts as a food for soil biota and generated bio-chemicals after decomposition in soil. Application of nitrogen and press mud cake increased dry matter, and cane and sugar yields. The use of press mud along with fertilizers enhanced the yield of sugarcane. The integrated use of press mud with urea 1:1 ratio at 180 kg $ha^{-1}$ is beneficial due to producing higher amounts of organic acids in calcareous soil, modified the physiochemical properties of soil and enhanced the cane yield (Sharma *et al*. 2002). Application of press mud at 6 t $ha^{-1}$ increased cane and sugar yields, while its application at 4 t $ha^{-1}$ with 5 kg Azotobacter $ha^{-1}$ produced similar results to 6 t press mud alone (Tiwari and Nema 1999).

## ***Incorporation of distillery effluent to the press mud***

Effluent added to press mud harboured more bacteria, fungi, and actinomycetes, indicating the more microbial activity. The spent-wash was a major pollutant, because of its high organic load. However, over a period researcher finds out, it uses as fertilizers in crop production. They considered spent-wash as dilute liquid organic fertilizer with high K content and it contained about 90–93 % water and 7–9 % solids. Apart from it 75 % of solids were organic and 25 % were inorganic. The most important thing is that its N content was mostly in colloidal form which behaves as a slow-release fertilizer and it was better than the other inorganic N source. It also contains macro and micro-nutrient in organic and inorganic states. The two-thirds of P were in organic form and the metabolic availability of which was more than any other elements, such as Ca, S, and Mg as well as Cu, Mn, and Zn. The distillery effluent contained large amounts of organic matter, N, P, K, S, and Ca besides high salt load, sulfates, and chlorides of K, Na, and Ca. Its use for nutrient purpose is required technology and regular monitoring of soil properties. The spent-wash is highly acidic having a pH range of 3.8–4.0, can be used as an amendment in alkaline soils. It carried a huge organic load, i.e., BOD (45,000-55,000 mg $L^{-1}$), COD (90,000-110,000 mg $L^{-1}$), and total solids (80,000-90,000 mg $L^{-1}$), which improve soil properties. The distillery effluent contains N, P, K, Ca, Mg, and $SO_4$ and it is, thus, a valuable fertilizer when applied to soil through irrigation water.

Table: crop residues and their composition

| Material | C: N | N (%) | P (%) |
|---|---|---|---|
| Rice straw | 60 | 0.58 | 0.10 |
| Corn stover | 55 | 0.59 | 0.31 |
| Cotton stover | - | 0.88 | 0.15 |

| | | | |
|---|---|---|---|
| Peanut hulls | - | 1.75 | 0.20 |
| Sugarcane | 116 | 0.35 | 0.04 |

## Impact of application of press mud on soil properties

Sugarcane industries generated wastes are organic in nature, and it has been tried to meet the nutrient requirements of various crops and cropping system as well as soil amendments. They contain significant amount of plant nutrients and organic matter improve soil properties. There are two types of press mud, and have different impacts on soil properties. In sulphitation process, press mud contains nutrient and $CaSO_4$, which is acting as a soil amendment in alkaline soils. Application of sulphitation press mud increases the crop yields, and improved chemical properties of soil. Press mud enhanced the P availability in soil by the effects of press mud and hence, carboxylates can be grouped into direct and indirect effects. The direct effects generally result in an immediate P release. During the decomposition of organic residues, a range of organic acids are produced, which mobilize the P from fixed sites and are easily available to plants. They refer to the blocking of P adsorption sites (ligand exchange), oxide dissolution by complexing Al or Fe held in minerals, or mobilization of P held in metal–humic substances. In the case of carbonation processed, press mud contains about 60 % $CaCO_3$ and can be exploited as an amendment for acid soils. Application of press mud in combination with rice straw enhanced the P availability and reduced the P fixation capacity in soil. It enhanced P availability by 68 % in soil solution and reduced P fixation capacity press mud. Addition of organic residue enhanced the soil organic carbon in soil and accelerated the microbial activities in soil. Soil microbial diversity as well as microbial population enhanced due to easily available carbon as a food material. Application of filter cake increased the cation exchange capacity for 30 months after its application and residual effect remains up to four years in soil.

## Conclusions

The time when cost of chemical fertilizer is skyrocketing and not affordable by farmers, press mud has promise as a source of plant nutrient and as a medium for raising sugarcane seedlings. It is organic in nature, and it augmented the soil chemical, physical, and biological properties as well as improves yield and quality of crop. It should be encouraged to use with inorganic chemical fertilizers under various cropping systems to enhance nutrient availability to plants. Use of this by-product as a fertilizer should be spread through creating awareness. It may be a best option for minimizing chemical fertilizer for crop production, especially heavy nutrient feeder crop like sugarcane.

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