Information Sheet

7.22 Inorganic amendments: Ash

Ash is the waste by-product from the combustion of bagasse as a fuel source in boilers for steam and energy generation in sugar mills. It is most often called fly-ash but is sometimes referred to as mill, bag, boiler, or bottom ash. It consists mainly of the mineral components of the sugarcane stalks and soil mineral contaminants left after the organic components have been burnt. Other types of ash that may occasionally be available to growers is ash from boilers fuelled with wood, sawdust or paper mill sludge, these with similar properties to bagasse ash. Together, these are referred to as biomass ash. In some cases, ash can be sourced from coal-fuelled boilers (or biomass boilers with coal used in supplemental co-generation). These ashes still have similar properties to biomass ash, though tend to contain higher levels of toxic elements and metals depending on the amount and source of the coal.

This information sheet provides information on bagasse ash, its key properties and how these can be beneficially used as a soil ameliorant. Consideration to other types of ash is also given to highlight special precautions that may be necessary. General application guidelines are provided.

▲ Ash delivered for farm use should be used as soon as possible after delivery. Ash piles are prone to wind and water erosion and may cake and clump if allowed to get excessively wet before use.

▲ Surface applied ash should be incorporated soon after application to avoid the formation of surface crusts. Ratoon topdressing is usually not advised.

▲ Ash is typically applied using a broadcast spreader to ensure even distribution over the soil. As ash can be corrosive and abrasive, depending on its properties, care must be taken when handling to avoid staff injury and equipment damage.

Benefits of applying ashes and slags to soil

- May neutralise soil acidity.
- Most supply low levels of plant essential nutrients and increase soil silicon reserves.
- Under certain conditions, they can improve soil structure.
- Porous ash products have been reported to improve soil water holding capacity and increase nutrient holding capacity.
- Can increase carbon content (not organic matter) of the soil.

Disadvantages and risks

- May contain toxic elements if sourced from coal co-generation boilers.
- Some products are caustic and require careful handling. Dust inhalation must be avoided.
- Some fine ashes can be very fine or prone to caking and clumping, thus difficult to apply using conventional spreaders.
- Surface application (without incorporation) can lead to surface crusting and runoff losses. Incorporation is advised for full effectiveness.
- Can be very abrasive to application equipment (increased maintenance required).

Properties of ash

Ash properties vary depending on feedstock materials used in boilers and the processes used to capture the ash. They can range in texture from fine powders to coarse granular materials. Ash collected from electrostatic precipitators tend to be fine, while ash from the bottom of the boilers tends to be coarser, though often these materials are mixed. Moisture and high humidity can lead to clumping and caking of the ash. Storage of ash in the open can also lead to leaching of nutrients and affect the moisture content. Testing of ash as close to application time is advised to ensure that application rate adjustments can be made.

The chemical properties of ash are strongly dependent on the chemical make-up of the boiler feedstock fuel and the efficiency of the boiler. Ash from bagasse and other clean biomass fuels (e.g. wood, sawdust) generally result in non-toxic alkaline ash, consisting mainly of calcium, magnesium, silicon, along with potassium, phosphorus and trace amounts of other elements and micronutrients (which is generally linked to the amount of soil contamination from the delivered cane). In most cases, these elements are found as oxides of the element (reactive alkaline metal compounds) or as silicate, glass-like compounds of varying reactivity. This also generally means ashes have low carbon, nitrogen and sulphur content (as these would have burnt off as gases), but this can vary depending on the completeness of combustion and methods used to clean smokestacks of boilers.

Generally, ashes are neutral-to-alkaline due to the formation of oxides and silicate minerals during combustion. Where they have adequate neutralising capacity, they can be an alternative to more conventional liming products. In some cases, slightly acidic ash is produced, this often associated with incomplete combustion of the feedstock material. Care must be taken when using acidic ashes to avoid unintended soil acidification.

Ashes must be tested for nutrient content to permit suitable rate adjustments and to allow discounting of conventional fertilisers and other nutrient sources. Assessing the neutralising capacity of ashes is also essential where these are to be used as a lime substitute (see Information Sheet 6.5: Liming materials and their use). Typical nutrient concentration ranges (total analysis) and approximate amounts per ton of ash of bagasse ash (dry) are given in the table below.

Product	N	P	K	Ca	Mg	Si	pH	NV[1]
Concentration %	0.1 - 0.5	0.04 - 0.5	0.3 - 3	0.15 - 2	0.15 - 1	10 - 40[2]	6-10	20-70
Kg per ton (dry)	1 - 5	0.5 - 5	3 - 30	1.5 - 20	1.5 - 10	100 - 400	-	-

[1] NV = Neutralising Value (or Calcium Carbonate Equivalence) is a measure of the capacity of the ash to neutralise soil acidity relative to pure calcium carbonate (which is set as 100%).

[2] Plant availability silicon is generally substantially lower than the total Si amount.

Where coal-derived ash is being considered, testing for toxic metals is essential to avoid any negative side effects to the soil, crop and environment. In general, coal-derived ashes are suitable for agricultural use if rates are adjusted to prevent over-application of toxic elements.

Application of ash

Typical ash application rates vary from 20 to 200 t/ha depending on the purpose of the application. As a low-grade nutrient source, higher rates are normally used. However, due to potential negative effects of excess salt loading, high rates (>100 ton/ha) should be restricted to well drained, clay (>15%) soils, while on sandy (<15%) soils rates should not exceed 100 t/ha. Where used as a potential silicon source, higher rates are required due to the relatively low availability of the silicon in the ash. Where the ash is to be used as a liming agent, the neutralising value (or calcium carbonate equivalence) must be determined and the application rate adjusted to ensure the desired level of acidity control.

For maximum benefit, ash should be applied to replant fields before land preparation. Ash should be evenly broadcast and incorporated into the topsoil. Avoid leaving ash, especially heavier application rates, on the soil surface as this can lead to surface crusts and increase the risk of losses due to wind and water erosion. Top dress applications in ratoon cane are generally not advised due to limited opportunity to incorporate the material into the soil and the risk of wind erosion.

In some instances, ash is blended with other mill by-products such as filtercake or used in the making of compost. Where such products are sourced, testing of nutrient and moisture content is necessary to permit nutrient application rate adjustments. Studies have found such blends often improve the properties of the ash, while also providing the combined benefit of the co-disposed organic amendment.

Cautionary notes

- Ashes can be caustic and abrasive thus suitable precautions for handling must be taken, and equipment cleaned after use.
- Inhalation of dust ash must be avoided, and suitable safety equipment must be used by operators.
- Do not apply ash to soils with an exchangeable sodium percentage (ESP) or sodium adsorption ratio (SAR) > 4 or where electrical conductivity > 200 mS/m as ash often contains high levels of soluble salts and along with high pH, can promote the development of sodic or saline conditions.

Sampling ashes

Testing of these products is usually advised to test for nutrient levels, neutralising value and other potentially toxic elements. As ash is often stored in piles, heaps or windrows, the following sampling procedure is advised:

- As there can be high variation in the piled or heaped material, it is preferred that the piles/heaps be thoroughly mixed before sampling.
- Several samples from different sampling locations and depths in the heaps must be collected.
- Collect the sample as close to the time of field application for most accurate results of composition.
- Samples can be collected using a spade or auger. Avoid galvanised sampling instruments as these can introduce zinc in the sample.
- Avoid collecting samples too close to the soil surface where the heap is located as soil can be introduced into the sample. Even a small amount of soil can result in anomalous results.
- Subsamples (20 – 30) can be placed and thoroughly mixed in a bucket before subsampling (about 500 grams) for analysis.
- Label the sample with relevant information required by the laboratory to ensure proper identification of the sample.
- If the sample cannot be sent for analysis immediately, then store in a cool dark place.

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