PRELIMINARY STUDIES ON THE COMPOSTING OF BAGASSE

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INTRODUCTION

Bagasse is a by-product of the milling of sugar cane. The major portion is used as a fuel source in the factories. However, there is a large surplus, which makes bagasse a cheap, readily available raw material. Over the years, various avenues have been investigated to find a suitable and profitable use for this by-product (Paturau, 1982). One such use is the conversion of bagasse into a compost support medium.

Various composting processes using bagasse have been documented (Castor Gomez and Park, 1983; Casey, 1982). A French process (Navarro and Gimutao, 1981) claims that, by the addition of a 'special' mix of bacteria, either filter press or bagasse (or a mixture of both) can be turned into high-grade organic fertiliser in two months.

The composting process involves the degradation of organic material by micro-organisms in a relatively aerobic environment (de Bertoldi *et al.*, 1985; Handreck, 1986). The cellulosic material and any residual sugars are the main components of bagasse that can be readily utilised by the micro-organisms already present in the bagasse. Assuming favourable conditions are attained during composting, the major products of the reaction are the compost, carbon dioxide, heat and water.

This paper briefly outlines the factors affecting good composting conditions and describes the results of some preliminary studies carried out on the composting of bagasse.

CONDITIONS FOR COMPOSTING

The important parameters governing the composting process are temperature, aeration, moisture and nitrogen content (de Bertoldi *et al.*, 1985). These are summarised below:

Temperature

The temperature during composting must be maintained between 55 °C and 60 °C for about the first two weeks in order to promote an active microbial population. If the temperature during this period rises above 65 °C, the microbial population is severely depleted, thereby retarding the decomposition process.

Aeration

The prime function of aeration is to remove the heat generated by micro-organisms and chemical reactions rather than to supply oxygen for aerobic decomposition. Adequate ventilation will remove the heat along with the water lost by evaporation. However, under anaerobic conditions, high levels of organic

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acids such as oxalic acid are produced. These remain in the compost and are detrimental to seedlings.

Moisture

The initial moisture content of the bagasse in the compost heap should be within the range of 68-73 per cent on a wet weight basis. For the critical first two weeks of composting, the amount of water lost through heat removal (water vaporisation) must not become excessive otherwise microbial activity is adversely affected. The amount of moisture lost during composting can be used as an indication of the success of the decomposition of the organic matter. Depending on the type of aeration procedure implemented, the final moisture content of the composted material is usually about 45 per cent for potting mixes.

Nitrogen content

The nitrogen content of fresh bagasse is not sufficient to maintain the microbial growth requirements during composting. Therefore nitrogen, generally in the form of urea, has to be mixed with the bagasse before the compost heaps are constructed to yield a carbon to nitrogen (C:N) ratio of 35 to 45. Too low a ratio will result in considerable nitrogen loss by volatilisation of ammonia from the composting heap.

MATERIALS AND METHODS

Composting of bagasse was studied in two trials carried out at North Eton mill. In the first trial, a heap (2 m high x 3 m wide x approximately 40 m long) was constructed from 120 m^3 of fresh wetted bagasse (55 per cent moisture) and 20 m^3 of rice husks. Urea was added as the nitrogen source to give a final C:N ratio of 70. Aeration was aided by mechanical turning of the heap with a front-end loader every three days for the first three weeks. A further three weeks were allowed for the compost to mature. This period of time is designated as the maturation stage.

In the second trial, a fan-forced aeration system was used in an attempt to improve temperature distribution throughout the heap. A small pile of 11 m^3 (1.3 m high x 2.7 m wide x approximately 6 m long) was constructed by overlaying fresh saturated bagasse (80 percent moisture) onto a course gravel base. Urea was again added to give a final C:N ration of 35. Temperature control was carried out by placing a thermocouple 800 mm below the top of the heap which in turn, sent a signal to an on-off controller with a set-point of 60 °C. While the temperature was above this value, the controller actuated the aeration system forcing air through a series of perforated PVC pipes set into the gravel base.

Representative samples of composting bagasse were collected from each heap over the trial periods. Temperatures were monitored from a series of probes set in the centre of each heap. Moisture and pH were measured according to Inkerman *et al.* (1988). The levels of nitrogen and organic carbon were determined as described by Piper (1955) and phytotoxins in compost extracts analysed by the methods of Zucconi *et al.* (1985).

RESULTS AND DISCUSSION

First trial

During the first three weeks of composting in the first trial, the internal temperature remained high and ranged from 60 °C to 75 °C. The latter is some 15 °C above the upper optimum for microbial activity in composting material. Under these conditions, the microbial populations would have been severely depleted, thereby dramatically affecting the efficiency of the composting process.

Most of the heat generated in large piles of bagasse is due to chemical oxidative processes rather than microbial activity (Ashbolt, 1986; Dixon, 1988). Thus, the regular turning of the pile would have assisted in maintaining these high temperatures for the first three weeks. When this practice was curtailed during the maturation period, the mean temperature declined from 65 °C to 45 °C.

Over the six weeks of composting, the moisture content of the heap slowly decreased from 55 to 43 per cent, whereas the pH increased from an initial value of 6.0 to 7.3. In both cases, these results are considered to be near optimal values for good compost. The phytotoxicity of the compost was investigated using a seedling bioassay and on growing plants in the field. Under both conditions, excellent plant growth was observed. However, the compost was of a coarse texture as evidenced by the presence of a considerable amount of lengthy fibrous material.

Second trial

The moisture content during the first week of the second trial decreased marginally from 80 to 75 per cent and remained constant thereafter. Concurrently, the temperature decreased from a maximum of about 65 °C after two days to 60 °C after seven days. As the latter temperature was below set-point, the fan was automatically switched off and aeration ceased. Normally, with fan-forced composts, high microbial activity is synonymous with high moisture loss (Finstein and Miller, 1985). Neither condition was achieved during this trial. The inadequate air supply to the heap resulted in excessive temperatures which would have reduced microbial activity as well as severely affecting evaporative moisture loss.

In contrast to the behaviour in the first trial, the pH increased from an initial value of 6.3 to 8.5 after ten days and then slowly decreased. This rapid rise in pH is due to the hydrolysis of an excessive level of urea to ammonia by the compost micro-organisms. This ammonia is either incorporated into microbial biomass, lost by volatilisation to the atmosphere or oxidised to nitrate/nitrite.

The compost produced during the second trial could not be tested at a comparable time (six weeks) to the first trial. Instead it was left a further 14 weeks to maturate and this resulted in a product with a pH of 6.0, a moisture content of 75 per cent and a C:N ratio of 300. When finally tested with a limited number of plants, excellent growth was achieved. In addition, the texture of this compost was of a superior quality to that from the first trial. The lengthy composting period had obviously allowed breakdown of the larger fibres.

SUMMARY

Preliminary trials were carried out on the composting of bagasse with aeration being provided either by mechanical turning or by fan-forced ventilation of the bagasse heaps. The inadequate ventilation obtained by using both types of aeration resulted in high pile temperatures during the important first two weeks of composting. These conditions would severely restrict microbial activity and thereby retard the decomposition process. Nevertheless, the compost produced from both trials supported good plant growth. For the production of a finely textured compost suitable for a potting mix, a lengthy period of maturation is required.

Mechanical turning of the heap appeared to result in the best composting conditions if the efficiency of the process can be gauged from the degree of moisture loss. In the case of fan-forced aeration, no conclusions can be drawn as the plant was underdesigned. Further studies will be required to assess the advantages and suitability of this system for the composting of bagasse. A range of nitrogen levels should also be included in these studies.

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