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Compostable Characteristics of Reject Materials produced during Industrial-Scale Corn Stover Biomass to Ethanol Conversion

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ABSTRACT. *Industrial scale corn stover biomass conversion to ethanol is taking its roots in Iowa. Stover, consisting of above-ground corn plant material other than grain (MOG), is baled at harvest and stored on-farms. Stored bales can deteriorate during storage resulting in reject stover unworthy of processing. Bales, that meet the ethanol conversion quality standards, are transported to the processing facility to prepare stover for the ethanol conversion process. Bales, consisting of stover and loose soil, are subjected to grinding and sieving to separate soil from stover, thereby, producing soil stover as a reject material excluded from the ethanol conversion process. Compostable characteristics of reject stover and soil stover, in terms of bulk density, free air space, total carbon, total nitrogen, total ash, organic matter content, moisture content, and air-filled porosity will be presented in this paper. Compost trials (n=3) are planned to be conducted in July & August 2017 using reject stover and soil stover under three different treatments of total carbon to total nitrogen ratios and two different particle sizes of reject stover (as-is and particle size reduced to less than 5-cm). Dairy manure from the university dairy facility will serve as the nitrogen source during these compost trials. Results of these trials in terms of carbon di-oxide evolution rates and changes in physical properties of bulk density, free air space, and air-filled porosity will be presented. These results will help to determine the optimum carbon to nitrogen ratios and particle sizes needed to achieve compost maturity and, consequently, to balance composting timelines in relation to reject material production rates.*

Keywords. *Stover, corn, soil, rejects, cellulosic ethanol, compost*

NOTE

This is not a complete paper as the authors were not able to get all the data in time to write it. Tests and analysis is currently under-way and a revised version of this paper will be available after the ASABE Meeting.

Introduction

Industrial scale corn stover biomass conversion to ethanol is taking its roots in Iowa. Stover, consisting of above-ground corn plant material other than grain (MOG), is baled at harvest and stored on-farms. Stored bales can deteriorate during storage resulting in reject stover unworthy of processing. These bales typically consist of bales which are at the bottom of the bale stack which have wicked moisture from the ground over time. Top layer of bales in the bale stack may also consist of reject stover as it is subject to moisture from rain and snow. Bales on all four sides of the stack may also deteriorate depending upon their exposure to the elements of nature, thus, producing rejected stover.

Bales in the storage stacks, which meet the ethanol conversion quality standards, are transported to the processing facility to prepare stover for the ethanol conversion process. Bales, consisting of stover and loose soil, are subject to grinding and sieving to separate soil from stover, thereby, producing soil stover as a reject material excluded from the ethanol conversion process. Soil stover does not consist of significant amount of stover particles to justify further separation and is, therefore, rejected from ethanol processing.

Both reject stover and soil stover can potentially be managed by composting resulting in composted material which can then be land applied. Given the nature of the materials, compostable characteristics of reject stover and soil stover need to be studied in order to identify key variable and their effect on the composting process. Reject material properties, in terms of bulk density, free air space, total carbon, total nitrogen, total ash, organic matter content, moisture content, and air-filled porosity need to be determined to establish the composting process. Mixing ratios then need to be determined and tested to evaluate their impact on the composting duration.

Objectives

A project to study the compostable characteristics of reject stover and soil stover was undertaken at Iowa State University in Ames, IA. The overall objective of the study is to measure physical properties and evaluate compostability of soil stover and reject stover in conjunction with dairy manure solids, beef feedlot solids, and liquid swine manure. The specific objectives of this project are:

1. Measure physical properties of specified materials in relation to their ability to compost,
2. Evaluate respiration rates for selected mix ratios and three different manures in a laboratory,
3. Evaluate composting process under different mix ratios of reject stover, soil stover, and three different manures.

Methodology

Bulk density, free air space, total carbon, total nitrogen, total ash, organic matter content, moisture content, air-filled porosity of soil stover and reject stover will be determined using approved methods in the Elings Hall Manure Analysis Laboratory. Respiration rates (CO_2 evolution) of five different stages of reject stover and soil stover when mixed with dairy manure solids or beef feedlot manure, or liquid swine manure will be tested.

Additional details on the methodology will be provided in the updated version of this paper which will be available after the ASABE National Meeting.

Results and Discussion

Tables 1 and 2 show select properties of the five different types of stover and soil stover. Additional data and discussion will be added in the revised paper to be made available after the ASABE meeting.

Table. 1	TS	VS	FS	Volatility	Total C	Total N	C:N
Material	%	%	%	%	%	%	
Reject Stover (A)	27.4	18.3	9.1	66.6	39.4	1.6	24.7
Reject Stover (B)	86.5	78	8.5	90.2	42.1	1.1	39.3
Reject Stover (C)	83.7	73.3	10.4	87.5	45.1	3.8	11.8
Reject Stover (D)	61.3	53.8	7.5	87.8	39.9	1.4	27.7
Reject Stover (E)	48	35.5	12.5	74	37.9	1.2	30.4
Soil Stover	89.6	65.6	23.9	73.3	40.6	2.3	17.6

Reject Stover (Ave)	61.4	51.8	9.6	81.2	40.9	1.8	26.8
St. Dev.	24.8	25.2	1.9	10.3	2.8	1.1	10
COV	40.4	48.7	20	12.7	6.9	61.7	37.4

Table 2.	Bulk Density	Particle Density	Porosity	Water Holding Capacity	Air Filled Pore Space
Material	kg/m3	kg/m3	m3/m3	kg/m3	m3/m3
Reject Stover (A)	52.2	818.5	0.9	321.7	0.6
Reject Stover (B)	37.6	600.2	0.9	227.2	0.7
Reject Stover (C)	69.4	1004.3	0.9	345.2	0.6
Reject Stover (D)	39.1	545.9	0.9	254.1	0.7
Reject Stover (E)	46.1	703.5	0.9	283.9	0.7
Soil Stover	206.2	1494.8	0.9	1491.8	0.0
Reject Stover (Ave)	48.9	734.5	0.9	286.4	0.6
St. Dev.	12.9	183.3	0	48.1	0
COV	26.3	25	0.4	16.8	7.6

A revised version of this paper will be made available after the ASABE Meeting in July.