Engineering, Structures & Innovation

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Nursery Mechanization Field Evaluations

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Significance to Industry: In recent years, an increasing number of off-the-shelf mechanized equipment offerings for the Nursery industry have made their way to trade show floors and dealer show rooms. As part of an overall effort to increase labor performance in the green industry, several pieces of equipment have been evaluated during field trials. These equipment evaluations were conducted over the past 18 months at various nursery locations and at the Mississippi State University Coastal Research and Extension Center.

Nature of Work: This project is part of a research effort currently being supported by the United States Department of Labor and the Mississippi Agricultural and Forestry Experiment Station entitled 'Enhancing Labor Performance of the Green Industry in the Gulf South' (1). The selection criteria for the equipment included in these field trials was based upon an Engineering Systems Analysis of both container and field production operations and included considerations for process requirements, efficiency opportunities and safety improvement potential. Equipment was tested in actual nursery conditions allowing nursery workers the opportunity, where practical, to offer feedback based upon their experience with the equipment. In addition, the equipment was used extensively at the Coastal Research and Extension Center where factors such as cycle time, user comfort and ease/difficulty of use were noted.

Results and Discussion:

Fertilizer Dispensing - As an alternative to the traditional time-release fertilizer dispensing method of using various sized scoops/cups to apply product into container grown plant material, two pieces of equipment were evaluated.

Backpack fertilizer dispenser - The Fertil™ Dispenser from the Simeoni Technogreen Company was tested with following results.

- Process cycle time studies showed an avg cycle time reduction of 25% over traditional methods. Learning curve was short. Proper adjustment of back straps and feed tube to the worker height are critical.
- Workers noted a significant reduction in fatigue allowing for extended periods of productive use.

- Hopper capacity is adequate at 35 lbs. Fairly easy to re-fill at ground level.
- Good repeatability in dosage with extended release fertilizers.
- Must keep dosing chamber clear of obstructions.
- Recommended for a small container operation based on max dosage.

Battery Powered fertilizer dispenser – The GreenElf® Applicator Models 301 and 501 from the GreenElfWorks® Company were tested with the following results.

- Process studies showed a cycle time reduction of 50%+ over traditional methods.
- Unconventional tube storage of fertilizer resulted in longer worker learning curve but allows for quick change-out of filled tubes.
- 21 lb fertilizer storage with the optional large storage tube. Excellent repeatability.
- Metered doses (3-78 grams) that works equally well with granular herbicide (Model 301).
- Productivity tracking options (dose count) worked well. Great battery life.
- Recommended for a small container operation but can dispense rapid fire shots which could benefit large container growers.

Large Container Moving - One selection of equipment to assist in the moving of large (< 15 gal) plant material was evaluated.

Hydraulic powered container mover - The PZ1200 from the Pazzaglia Company was tested with following results.

- Reduction in manpower required when moving 15+ gal containers (up to 48" in diameter).
- Large increase in worker safety by eliminating heavy lifts/drags.
- Capacity of approx 2200 lbs.
- Successful transport of B&B product as well as containerized.
- Marginal performance on soft/wet terrain with turf drive tire. Suspect that available tractor tread tire would remedy this.
- Good maneuverability in tight quarters. Ability to easily traverse moderate (20°) incline with 45 gal containerized tree.

Pruning - One selection of equipment to assist with the pruning of plant material was evaluated.

Battery powered hand pruners - The Felco 800 from the Felco Company was tested with following results.

- Evaluations showed moderate cycle time reductions and significant reductions in fatigue. Very good Ergonomic benefits to the hands and wrist of the worker.
- Very good battery life of 8+ hrs driven by the diameter of material being cut and worker discipline in maintaining a sharp blade.
- Comfortable backpack style battery.
- Most practical for large tree pruning or root pruning bare-root product. Too bulky for obtaining smaller propagation cuttings.
- Easily cuts material to 3/4"

Spraying of Herbicide - One selection of mechanized equipment to assist with the spraying of herbicide was evaluated.

ATV Mounted Sprayer – An Enviromist sprayer fitted with an Undivina spray head from the Enviromist Company was tested with following results.

- Reduced chemical usage through reductions in volume required and application control (reduced drift).
- CDA (Controlled Droplet Application) technology applicator is key and cleanliness of unit determines long term effectiveness.
- Adequate control with 4-Wheel ATV, although users rate performance better when attached to a small tractor.
- Breakaway spray head produced no damage to tree trunks.
- Most suitable for field production, although can be used in any area with reasonably flat terrain. Unit will not perform well in undulating terrain.

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Evaluation of Windrow Composting Versus In-Vessel Digester Composting of Poultry Litter for Use in the Green Industry

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Significance to Industry: Currently around 419.12 million metric tons (463 million short U.S. tons) of poultry manure is generated in the United States each year (5). Some resulting issues facing the poultry production industry include: reduced land area on farms to apply increasing amounts of litter; nutrient management plans that are based on phosphorous indexes; and land applying poultry litter to clay soils that already have high phosphorous (3). Scientists and industry have increased awareness of composts; in particular poultry litter compost. Based on the nutrients available in poultry litter compost, the green industry could provide a means to use these materials. The significance of this study is an evaluation of two composting methods of poultry litter; one being windrow composting, the other in-vessel digester composting.

Nature of Work: In Alabama alone there were a total of 1.1 billion broilers produced during 2007 accounting for 12.4% of the national total of 8.9 billion poultry birds. As a result 51.971 million metric tons (57.412 million short U.S. tons) of poultry litter were produced in the state of Alabama last year alone (1). Poultry manure is rich in both macro and micro plant nutrients (7). Poultry litter consists of the bedding materials used, the manure from the bird, spilled feed, and feathers. The bedding materials commonly used in the southeastern United States can include wood shavings, sawdust, peanut hulls, straw, and pine bark. The objective of this study is to determine the best possible way to compost poultry litter in the most economic, environmental, and beneficial ways for subsequent use in the green industry.

Historically, fresh poultry litter has been used as fertilizer that is spread over agronomic fields, as a fuel source for heating, as cattle feed, as a substrate component in container plant production, and also as an erosion control product. The purpose of composting poultry litter is to kill pathogens that may be within it, reduce the weed seed, reduce the amount of nitrogen per pound of litter, reduce the volume, and to reduce the odors associated with the high level of ammonia found in raw poultry litter. Environmental concerns for using litter include nutrient loading of soils that are already high in phosphorous, leaching of nutrients into streams and other water ways, which in turn can lead to Eutrophication and blue baby syndrome (3).

Compost is defined as the biological stabilization of organic wastes under controlled conditions of oxygen, moisture, and temperature. The end result is a stable organic product. The benefits of using composts in the green industry are numerous but a few include the ability to improve soil fertility by providing nutrients, increasing cation exchange capacity, enhancing populations of soil microorganisms, and an increase in water retention (4).

In order to begin the composting process appropriate materials should be piled together. The initial mixing of the raw materials introduces enough air to start the process. Almost immediately, microorganisms consume oxygen, and settling materials expel air from pore spaces. Aeration is provided by passive air exchange or by forced aeration. Temperatures of the composting materials usually increase rapidly to 38-60°C (100-140°F) and remains in this range for several weeks (assuming it is not in-vessel, in this case the compost process is accelerated greatly and temperatures remain in this range for a few days or couple of weeks). Other essential elements in the composting process are carbon-to-nitrogen ratios in the range of 20:1 – 40:1 (C: N ratios above 30 will minimize the potential for odors). Moisture content is critical to the composting process with 40%-60% ideal, depending upon the specific materials, pile size, and/or weather conditions. If the moisture content is too high water will fill the air spaces leading to anaerobic conditions causing microbes to die off and odors to rise. Pile porosity, which determines how well air can enter and diffuse into the composting mass is also critical and should be around 40% (2).

Generally windrow widths are determined by the equipment used to turn them, formed in heights of 3-4 feet, with length limited to available space (6). An in-vessel-digester system however, is a rotating drum system which allows for breakdown in a few days compared to weeks in the windrow system (2). These drums can measure from 3 feet in diameter and 12 feet long all the way to 16 feet in diameter to 230 feet long (8).

The methods used to date to evaluate the processes described above are as follows. On July 25, 2007 we began the composting process for a windrow. The windrow was divided into two sections - one considered west, the other east. Two temperature data loggers were placed into the windrow at each end which recorded temperatures every hour. On the same date approximately 9 yards of fresh poultry litter was added to an in-vessel digester to begin composting. After eight days in the in-vessel digester the litter was removed and placed in a pile beside the windrow with two temperature data loggers placed to record at the same interval as the windrow. This allowed for the same atmospheric conditions to occur for both treatments. In addition to temperature data, moisture content, and carbon to nitrogen ratios, bacterial samples were collected and monitored.

A weed germination test was installed at Paterson Greenhouse Complex at Auburn University Auburn, Alabama on 2/27/2008 and ran until 4/09/2008. The procedures used were a completely randomized design. Twelve four - inch cups were filled within ¾ inch of cup edge with 100% in-vessel digester composted chicken litter (treatment D) or windrow composted poultry litter (treatment W) and watered in. The length of the study was 6 weeks during which the treatments were watered daily by hand. Weed counts were to be on a weekly basis. The litter used for this study had been fully composted to a point of temperature stability and uniform particle size in 2007.

Results and Discussion: At the start of this experiment our hypothesis was that the in-vessel composting method would occur much faster than that of windrow composting due to the rapid breakdown of the raw material. However the data loggers revealed considerable temperature changes within the pile after it was removed from the digester. These temperature changes occurred very rapidly over the next several weeks (data not shown). The results indicate that although the materials looked finished and there was no longer any odor associated with the composted poultry litter, that it in fact the composting process was not completely finished breaking down into a stable organic product.

At the end of the six week study no weeds were present in either treatment nor were they present at any interval within the treatment. There was no significant difference between the two methods.

At this time there is no evidence of any significant difference between the two methods, however there are still numerous tests and evaluations to be done in order to effectively evaluate each method and the pros and cons associated with each. Equipment costs, labor, and other inputs vary between methods with details to be reported at a later date.

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