Behaviour and composition of Alfalfa Green (AG) compost compared to coffee grounds and grass clippings in small-scale composting systems

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Abstract

The objective of this experiment was to study the behaviour of Alfalfa Green (AG) in a mini-composting system compared to common household ingredients such as grass clippings and coffee grounds. We created three mini-compost systems using AG, coffee grounds, and grass clippings as the nitrogen (N) sources, and compared the behaviour of those three systems to each other as well as to a fourth system (control) with no nitrogen source. Each system was composed of layered vegetable scraps, sawdust, their respective N sources, and a small addition of soil to add the desired microorganisms. These base ingredients were put into the containers using ratios calculated to yield as close to an ideal C:N ratio (between 25:1 and 35:1) as possible. The systems were checked several times a week and internal temperature readings were taken at that time to monitor microbial activity until the end of the 90-day test period. The systems were turned regularly to mix air throughout the compost and watered (or drained) as necessary to maintain an ideal moisture content. It was found that the AG pellets consistently had higher internal temperatures and, overall, composted faster and more completely. An additional observation was made of the abundance of insects and larvae within the AG system.

Introduction

Alfalfa Green is a plant-based soil amendment and slow release fertilizer made from alfalfa forage grown and manufactured near Norquay, SK at Western Alfalfa Milling Company Ltd. (WAMCO). Although dehydrated alfalfa pellets have traditionally been used for livestock feed, the pellets have recently caught the attention of the "Green Movement" as an environmentally friendly and economical fertilizer and soil amendment. AG has applications in the reclamation and remediation industries, gardening and landscaping sectors, as well as in individual homeowner lawn care, gardening, and horticultural applications.

There are five crucial ingredients to any layered composting system: air, moisture, nitrogen, carbon, and microorganisms. The sources of carbon (or "brown" ingredients) are typically items high in carbon such as cardboard, leaves, branches, shredded paper, or sawdust. For example, the sawdust used in this experiment has a C:N ratio ranging from 100:1 to 500:1 and typically landing around 350:1. "Green" compost ingredients are classified as such by their low carbon to nitrogen (C: N) ratios. Green ingredients activate the compost by boosting the metabolic activity of the microbes and moderating the high C:N ratio of the brown ingredients. Maintaining a C:N ratio between 25:1 and 35:1 creates the ideal environment for the microbes responsible for decomposing plant-based materials and promotes activity. The microbial activity generates heat, which can then be used as an measurable indicator of the progress of the compost systems.

Alfalfa Green is green in colour, in terms of production, and when speaking of environmental stewardship. Now it has shown itself to be an excellent "green" ingredient in compost systems. As part of the green category, AG pellets have a C: N ratio that ranges from 11-14 parts carbon per unit of nitrogen, or 11:1 to 14:1. A comparison of alfalfa pellets to other green ingredients can be found in Table 1. This high level of nitrogen, along with the neutral pH and wide range of micro and macronutrients, makes alfalfa pellets an ideal compost activator and green ingredient.

Materials & Methods

Following instructions found on a variety of websites, including the Compost Council of Canada (2010) and Planet Natural (2014), compost systems were designed to mimic what a typical homeowner would try in his/her backyard. The ideal C:N ratio for microbial activity lands somewhere between 25:1 to 35:1, landing at an average of 30:1. For this project, C:N ratios were calculated by adjusting the proportions of each ingredient in the system. A summary of these C:N ratios are shown in Figure 1.

Brown Ingredient	*Average C: N Ratios*
Sawdust	350:1
Green Ingredients	
Grass Clippings	22.5: 1
Kitchen Scraps	25: 1
AG Pellets	12.5: 1
Coffee Grounds	20: 1

Table 1: **Comparison of C: N ratios of ingredients used in WAMCO compost experiment.**

The compost chambers were made by taking empty food buckets from Rawhide's Bistro and Saloon, and drilling ½" holes in them. They were approximately 5 gallons or 20 litres. Holes were drilled in the sides to allow for air movement, which aids in the decomposition process. The proportions of the different materials were adjusted to generate an overall C:N ratio of around 30:1. The calculator tool and general formula were found on the Cornell Composting website (Cornell, 2015). A summary of the proportions and ratios are seen in Figure 2.

Ingredient	Carbon: Nitrogen	#1 Control	#2 AG	#3 Coffee	#4 Grass
Kitchen Scraps	25:1	800	1	1	1
Alfalfa Green (AG) Pellets	12.5:1	-	17.2	-	-
Grass Clippings	22.5:1	-	-	-	72
Coffee Grounds	20:1	-	-	33.6	-
Sawdust	350:1	1	1	1	1

Table 2: **Proportions (by weight) of ingredients to create the ideal C:N ratio for microbial decompostition for each of the four compost systems.**

Because the experiment was meant for a target audience comprised of homeowners, do-it-yourselfers, and gardeners, the chosen ingredients were ingredients that would in systems that would be found in a typical backyard compost bin. Kitchen scraps (mostly vegetables) were taken from Rawhides Bistro and Saloon in Stenen, SK. and used as the material to be decomposed in the systems. Although vegetable scraps are usually considered a source of nitrogen, the moisture content was high enough that the impact of the scraps on the C:N ratio was negligible. According to the C:N calculator used for the other systems, it would take 800 parts of vegetable scraps per one-part sawdust to get the ideal C: N ratio for decomposition. This is the reason behind using activators such as coffee grounds, grass clippings, or coffee grounds as the main N source.

The purpose of composting is to reuse, so for this experiment most ingredients and materials used were recycled from other uses. This includes the kitchen scraps, containers, and coffee grounds that were gathered from the kitchen at Rawhides. The grass clippings were taken from the yard at WAMCO, and the sawdust was swept from under the planar mill at Edgewood Forest Products in Carrot River, SK. The AG pellets used in the experiment were past production samples kept for quality control purposes but were no longer needed.

Figure 1: **The #1 Control system approximately 15 days into the 90-day trial period. The sawdust, vegetable scraps, and soil were mixed together in the 5-gallon pail with holes drilled in it to allow for air movement.**

Soil was added to the compost pails to introduce microorganisms into the system. In literature, the compost pile is set right on the ground and the soil's natural macro and micro fauna is free to access the pile at their leisure. Because our experiment was conducted in containers to allow for a more controlled environment, we had to manually introduced the microorganisms into the system. Like the vegetable scraps, the soil was added in such small amounts that it did not effect the desired C:N ratio. Although it was a necessary ingredient it was not taken into consideration when calculating proportions of each ingredient.

To avoid overheating of the compost pile and to mix the crucial final ingredient- air- throughout the pile, each system was turned frequently. This was done if the temperatures started falling or if there was too much moisture. The intent was to keep the temperature between 55° and 75° Celsius with moisture levels remaining moist but not soaking wet. Temperatures any higher than that would kill off the desired microorganisms or lower would not denature any weed seeds or diseases hidden in the compost ingredients. A system that is too dry would not promote microbial activity, and a system that is too wet would promote fermentation and rotting, not microbial decomposition.

The temperature of every system was taken every morning and afternoon several days a week to track the compost behaviour of each of the systems. These temperatures were recorded in a spreadsheet along with observations for the duration of the 90-day test period (beginning July 19th, 2016 and ending on October 17th, 2016). Typically, compost does not follow a set timeline and its

Figure 2: **The four compost systems were visually compared at the end of the 90-day test period.**

"completeness" would be a judgement subjective to whoever was controlling the system, much like the "correct" moisture level. This experiment, however, was designed to compare systems during a set timeline. Regardless of the level of completion at the end of the 90 days, a visual analysis of "completion" was conducted and samples were taken of the post-compost material. Figure 2 shows the final materials of each system at the end of the 90 days.

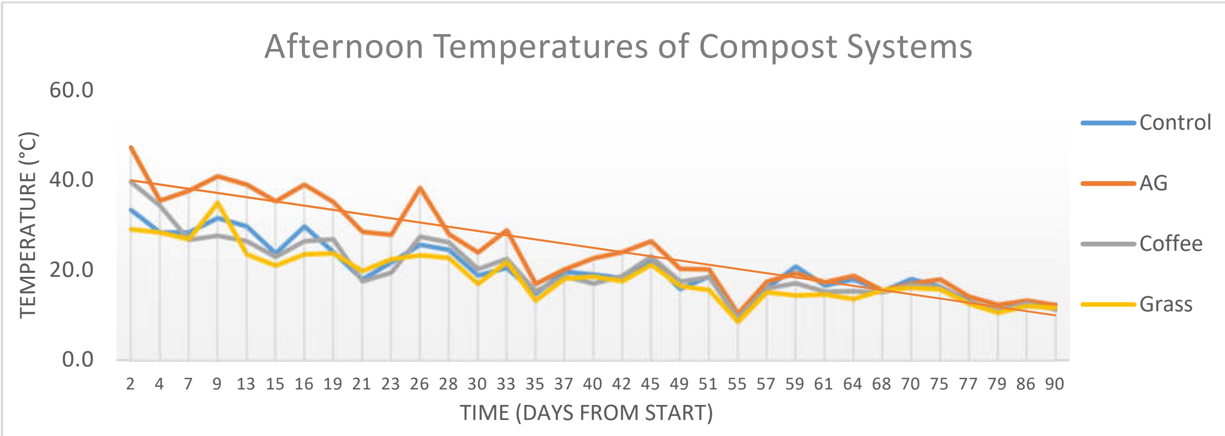

Figure 3: **This line graph shows the trend of the internal temperatures of the four compost systems over the 90-day trial period. The AG temperatures were generally higher than the other systems until the system reached completion about 70 days into the trial. The Control system was still about halfway through its decomposition process while the other three systems (that had additional nitrogen sources) were complete- or mostly so- by the end of the trial period.**

Results & Observations

Of the four systems, the Alfalfa Green (#2 AG) had the highest temperatures and finished the soonest. The AG system had a maximum temperature of 50.8°C and a minimum temperature of 8.7°C, with an average of 23.9°C. The coffee grounds system (#3 Coffee) was the next highest, having an average temperature of 19.8°C, a max temperature of 40.5°C and a minimum of 9.3°C. The difference between these two systems was the effort required to manage the moisture content. The #3 Coffee system required close monitoring and often needed to be watered or drained. This would be a complication that might deter most homeowners from using coffee grounds as a nitrogen source for home composting. The #2 AG system required the least maintenance, maintaining an even moisture level throughout the 90 days and only requiring additional water once or twice, whereas the coffee needed to be drained and turned to keep the system from rotting. The control and grass clippings systems required constant watering and turning to maintain the ideal moisture conditions. A summary can be found in Table 3.

	#1 Control	#2 AG	#3 Coffee	#4 Grass
Average	19.7	23.9	19.8	18.7
Maximum	33.8	49.0	40.5	33.1
Minimum	8.8	9.6	9.3	8.1

Table 3: **The above table summarizes the average mean temperatures, average maximum temperatures, and average minimum temperatures of the four composting systems.**

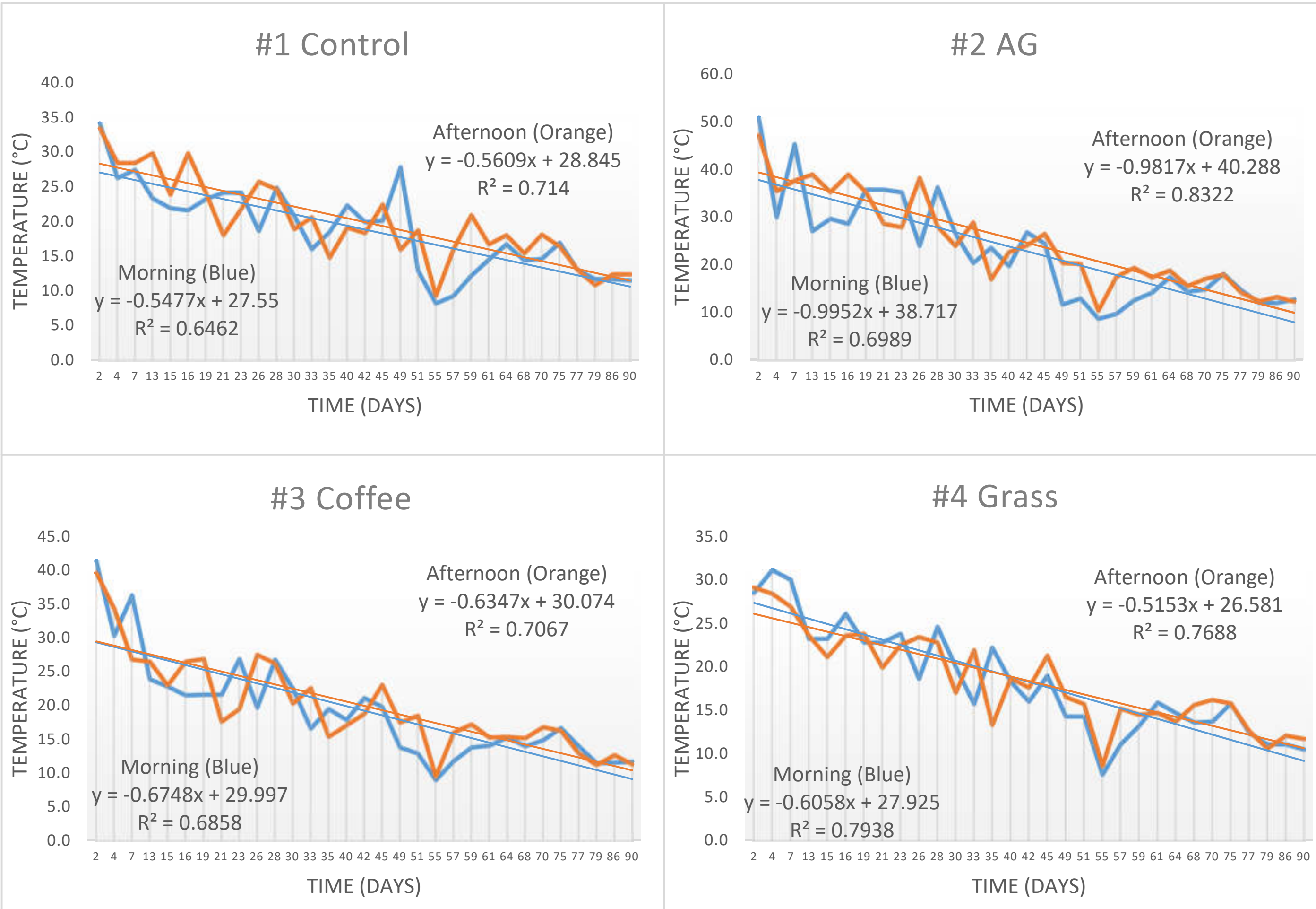

***Figure 4:* These line graphs show both the morning and afternoon temperature trends of each of the four compost systems over the 90-day trial period. Morning temperatures are shown in blue and afternoon temperatures are shown in orange.**

There were several additional observations recorded during the trial period. The first was the delayed spike in microbial activity in the control system. As seen in Figure 3, the temperatures for #1 Control were just beginning to have a positive slope, showing microbial activity typical of systems at the stage where optimum decomposition occurs. The control system was just starting to get going while the other systems were complete (or nearly so). This delay in the decomposition process can possibly be attributed to the lack of a nitrogen activator.

The second observation of interest was the presence of insect activity and larvae in the #3 AG system throughout the duration of the project. Several possible reasons for this are: the availability of partially denatured proteins from the AG, the heat generated from the microbes, the neutral pH, and/or that the moisture level had created an ideal habitat for both the beneficial microbes and insects. There was a notable lack of smell in all the systems, proving that the material was being broken down in an aerobic environment. If the decomposition had occurred in an anaerobic environment, the systems would have rotted and created an unpleasant smell.

Conclusion

This in-house composting project could be considered a pilot project, validating the need for a larger, more in-depth study. The results were positive, indicating that AG is a good compost activator and nitrogen source for the microbes responsible for decomposition. AG temperatures were consistently higher than the other systems, and therefore the fact that the decomposition process of the AG system was complete before the other systems was no surprise. The higher temperatures indicated that the microbes were more active and working harder at decomposing the compost materials. The AG compost was finished approximately 20 days before the end of the 90-day trial period. Furthermore, the amount of insect activity in the AG system compared to the other systems was a positive indication of how the pellets impact soil ecosystems.

The system using coffee grounds as a nitrogen source was the most prone to being too wet and required constant draining and mixing to maintain air circulation. Other than the tendency to be too wet, this system was the most comparable to the AG in terms of temperature and behaviour. The #4 Grass system was the slowest to decompose aside from the control, and had the lowest temperatures of the systems with nitrogen sources. This could be in part due to the smaller amount of material in the system causing it to be more sensitive to ambient temperatures. The system with no nitrogen source was very slow to decompose. In Figure 2, the visual analysis of the systems showed that the control system was largely undecomposed whereas the other three systems showed signs of being at least partway through the decomposition process. The conclusions reached in this report would benefit from a larger, more in-depth research experiment.

Implications

This in-house experiment was designed to validate the need for a larger project using Alfalfa Green in compost systems. Although the project was designed to emulate what a homeowner would try, the results show potential for the use of Alfalfa Green in commercial composting systems such as for cities, towns, or municipalities. A bigger experiment would prove whether the results from this trial work at a commercial scale. This project does, however, show that applying Alfalfa Green has a benefit at a backyard homeowner’s scale.

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