Litter Management for Broiler Production

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Introduction

Litter management is increasingly important for successful broiler production particularly with the adoption of antibiotic-free broiler programs by many integrators in recent years. Litter conditions during a chick's first several days of life impact health and performance over the life of broiler flocks. Proper litter management, together with heating and ventilation programs, directly affects the indoor air quality, especially aerial ammonia level. Chronic exposure of poultry to elevated aerial ammonia can have significantly detrimental economic effect to poultry production. This factsheet discusses basics of litter management and best management practices at different stages of broiler production.

Litter Management after Bird Harvest

After birds' harvest, litter is typically decaked by removing the crusted surface layer of the litter before multiple passes of tiling to allow release of moisture and other gases from the built-up litter, and to achieve a uniform litter surface for an upcoming flock. Typical downtimes vary from two to four weeks and tend to be longer under the antibiotic free program.

Litter Windrowing

Litter windrowing involves pilling up litter into rows of 18-36 inches high down the length of the broiler houses. As a result of the composting process, the windrow generates heat and temperature rises if litter moisture content is correct. Litter that is too dry does not heat well. The generally accepted minimum windrow temperature recommendation is 130°F or higher over the course of five to seven days to destroy pathogenic microorganisms. The challenge of a proper windrow practice is the uneven heating of the litter on the surface compared to the interior. Liang et al. (2014) reported peak surface temperature of windrow piles between 80 and 90°F. Turning windrows mixes the cooler portion of the pile with the warmer portion, increases aeration, and releases moisture and ammonia causing a second temperature rise (Figure 1).

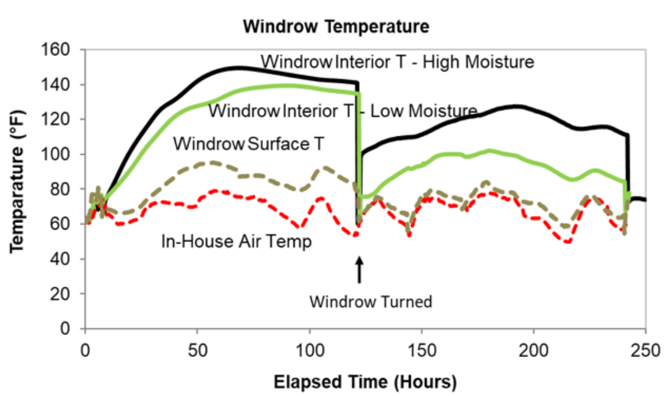

Figure 1. Temperature profiles of windrow interior and surface, and in-house air. Windrows were turned on five days after initial windrow formation. High moisture windrow: water of 900 gallons was added to the litter in a 40 × 400 foot house immediately before windrows were made. Low moisture: windrow received no additional water (Liang et al., 2014).

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A frequently asked question regarding windrowing is whether additional moisture is necessary. For growers who wash down their houses once in a while, a couple thousand gallons of water may be used. How does this water affect the windrow process?

Often, producers' best management practices in achieving drier litter during grow-out are in conflict with establishing a fast, successful windrowing process, because most litter has a lower moisture content than what is required for optimally heating the litter during windrowing. Liang et al. (2014) added 900 gallons of water to one windrowed litter and no additional water to another. With 900 gallons of added water, moisture content was expected to increase by 3.5 percent after two flocks on the reused litter, but only by about 2 percent after five flocks of litter usage. A significant decrease in litter moisture content occurred after seven to 13 days of windrowing, although the moisture content of the windrowed litter with water addition was slightly higher than that without water addition. However, windrows with water added had higher temperatures and stayed hotter longer (Figure 1).

In general, there were no negative impacts of windrow treatments on litter quality (Liang et al., 2014). Water-soluble phosphorus increased in both the windrowed and non-windrowed litter (Liang et al., 2014). This indicated that an appreciable degree of biotic (living factors — bacteria, fungi, and viruses) and abiotic (non-living factors — temperature, ammonia, season, etc.) activity occurred in the litter after flocks were removed, either windrowed or not. Macklin et al. (2008) reported no difference in Clostridium populations recovered from litter windrow composted versus uncomposted when the litter was windrowed for seven days without turning or adjustment of initial moisture content; however, they observed a significant reduction in Salmonella populations. Both aerobic and anaerobic bacterial counts were lower in composted than uncomposted litter before chick placement (Macklin et al., 2006). A decrease of anaerobic bacteria by windrow treatment on day 17 was found compared with nonwindrow treatment (Barker et al., 2011).

Litter Management Prior to Chick Placement

Pre-heating houses to raise air and litter temperature in advance of bird placement is critical in establishing the proper microenvironment before the arrival of chicks. A preheating period of 36-48-hours before chick arrival is important to allow the litter to reach the proper temperature. Air temperature will rise rapidly after the heat is turned on, but it takes much longer to thoroughly warm the mass of litter on the floor. Temperatures measured in a winter flock at northwest Arkansas showed an instantaneous rise of air temperature, but 40 hours' delay of litter temperatures measured three inches below litter surface and two feet away from a sidewall during pre-heating (Figure 2). Litter temperatures measured at this location were consistently lower than the air temperature during the first week of brooding. Baby chicks are not able to control their body temperature very well and quickly become chilled if placed on cold litter, which hinders their search for feed and water. Since ammonia volatilization increases as litter temperature increases, proper ventilation is necessary during pre-heating.

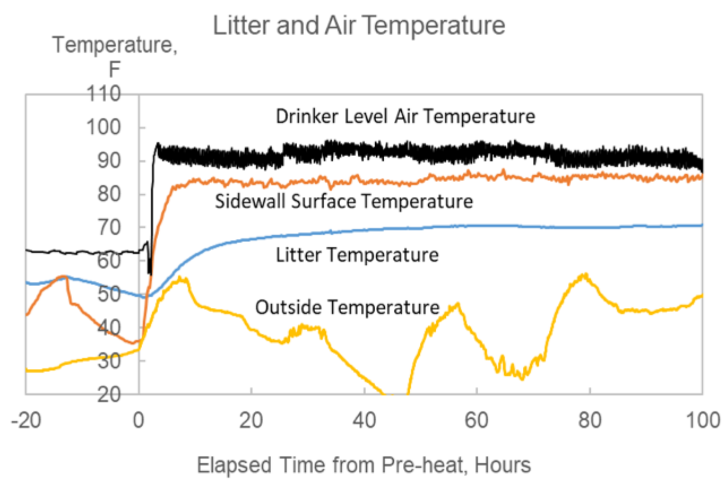

Figure 2. Temperature profiles of in-house air, sidewall surface, litter close to sidewall, and outside air from a commercial broiler house. Pre-heating started at time zero, with chicks placed about 28 hours after pre-heat. Litter temperatures were measured three inches below litter surface at two feet away from a sidewall.

Litter Amendment

The application of litter amendments through litter acidification has become a widespread management practice in the commercial broiler industry since ammonia production is favored by high pH. Ammonia irritates the eyes and respiratory system of birds (and humans) and reduces resistance to infection. Significant performance reductions such as reduced body weight gain, poor feed conversion, and even blindness can occur in flocks as a result of long-term exposure to aerial ammonia levels exceeding 25 ppm.

Acidifiers create acidic conditions in the litter, reducing conversion of ammonium (nonvolatile) to ammonia (volatile), or react with ammonia by donating acid ions, converting ammonia (NH_3) to ammonium (NH_4^+), a highly reactive ion that bonds with nitrates, phosphates and sulfates forming stabile ammonium salts that are retained in the litter. The acidity also inhibits the activities of bacteria and enzymes that are involved in the formation of ammonia, reducing ammonia production. Application rates recommended by manufacturers range from 50 to 150 lb/1,000 ft^2 (Table 1) depending on active ingredients (i.e. sodium bisulfate, aluminum sulfate, and so on). Research has shown that aerial ammonia concentrations were reduced with extending ammonia suppression for an additional week, as application rates increased from 50 to 150 lb/1,000 ft^2.

If litter is windrowed, additional litter amendment may be needed. The increased temperatures created by windrowing litter can lead to increased ammonia volatilization during and immediately following the windrowing process. Upon windrow disturbance (turning and re-spread), ammonia is often volatilized to the ambient environment, together with moisture evaporation. If not managed properly, unexpected high ammonia concentrations could sustain for an extended period after windrowing and negatively affect the subsequent flock. Without a litter amendment, at least four days are necessary to purge ammonia with adequate ventilation before chick placement (Liang et al., 2014). Using a litter amendment is a better choice than running the fans more often during cold weather without a litter amendment.

In addition, applying litter amendment immediately after re-spreading windrows is not recommended, and waiting for at least three days is suggested. Otherwise, the high ammonia released as the litter cools and dries will overwhelm the litter amendment and reduce or eliminate its ability to maintain a low litter pH during the first few days of the flock.

Litter Management During Grow-out

Prevent Wet Litter

"Wet litter" occurs when the accumulation of water changes the properties of the litter in ways that are considered to be detrimental to the health and welfare of the birds, production efficiency, food safety and/or the environment due to odor and ammonia production. Litter moisture management involves reducing the amount of water going into the litter, and increasing the amount of water evaporation from the litter.

Many sources in broiler houses add water to the litter, including excreted moisture, normal drinker spillage, leaking drinkers, building leaks, condensation and water vapor in the air (humidity). When one or more of these are greater than normal it can contribute to the onset of wet litter. Excreted water is one of the primary sources of regular water addition to the litter. Under normal conditions, water added to the litter from excretion is 12 to 80 gal/1,000 ft^2 per day during the grow-out cycle (Dunlop et al., 2016). If birds congregate at higher than average density in particular parts of the house due to uneven condi-

Table 1. Commercially available acidifier-type poultry litter amendments

Amendments	**Al+Clear**	**Al+Clear A7**	**Poultry Guard**	**Poultry Litter Treatment**	**Klasp**
Manufacturer	General Chemical Corp.	Affinity Chemical, LLC	Poultry Guard	Jones Hamilton Co.	Kemira
Common names; formula	Alum; aluminum sulfuric acid, $Al_2(SO_4)_3 \cdot 14H_2O$	Pure7; Acidified Alum, Acid/Alum Blend; 7% sulfuric acid	Acidified clay; 36% sulfuric acid soaked in a type of clay	PLT; 93% sodium bisulfate ($NaHSO_4$)	Ferric sulfate; 20% iron, $Fe_2 (SO_4)_3 \cdot 9H2O$
Type of product	Solid (powder + granules) or liquid	Liquid	Granules	Granules	Granules
Manufacturer recommended application rates before each placement (lb/1,000 ft2)	50-75	20-25 gallon (equivalent to 75 - 100 lb dry)	50	75-100 (litter of 1 year old or less)	75-100 lbs/1000 ft2
	75 (litter with more than 5 flocks, short layout or extremely dry litter)		75-100 (litter older than 1 year, deep litter, shorter layouts)	100-150 (litter of 1 year old or less)	
Application timing before placement	5-7 days	3-5 days	0-3 days	2-24 hours	2-5 days
Application methods	Surface apply with feeders and drinkers raised, mixed into top 1/2 inch	Surface apply with feeders and drinkers raised; a vehicle with a storage tank, a pump and spray nozzles	Surface apply	Surface apply, broadcast or drop spreader	Surface apply
OSHA[1] Communication Standard for safety	Hazardous	Hazardous	Corrosive	Irritant	Irritant

[1]Occupational Health and Safety Administration

tions such as temperatures, lighting, drafts or litter condition, it can lead to wet litter forming in localized areas. Drinkers are the second important source of water addition, and should be managed in terms of height, pressure, etc., to minimize leakage and avoid cake forming underneath the drinkers.

Moisture at the litter surface requires special attention. Water is routinely applied at the surface from drinker spillage, bird excreta and possible absorption of humidity from the air. Water is also evaporated from the litter surface. If the surface is damp, manure crusting and/or caking occurs, which slows the rate of drying from the litter surface and the movement of water into the litter below the caked surface.

Over the course of a grow-out, the total amount of water added to the litter is more than 2,400 gal/1,000 ft^2 (Dunlop et al., 2016), which is several times more water than the litter can hold, highlighting the necessity of regular water evaporation and removal from the house using ventilation.

During the grow-out, water evaporation is the only way to remove moisture from the litter to outside by ventilation, assuming that the in-house relative humidity is low enough. Research indicated that relative humidity of 75 percent is sufficient to cause wet litter or results in litter surface caking. Sufficient moisture-laden air needs to be exhausted from the house to prevent the in-house relative humidity from increasing. Adequate wall inlet vents and static pressure control allow mixing of the incoming air with warm in-house air so that warm, low humidity air can reach the litter surface and promote drying. The use of thermal de-stratification fans is a popular strategy before transitioning into tunnel ventilation.

Multiple Applications of Litter Amendment

Given the limited extension of ammonia mitigation potential from increased initial applications, a strategy of bi-weekly repeated application at 50 to 100 lb/1,000 ft^2 was reported to be more effective in mitigating ammonia volatilization throughout the grow-out period. Live performance or footpad quality was not affected by the repeated application (Purswell et al., 2013).

Summary

Floor-raised broilers rely on the litter for their wellbeing and ultimately achieving their growth performance. Poultry growers need to have a better understanding of and pay close attention to litter management practices, such as windrowing, ventilation, and acidifying amendment use in order to ensure that the in-house environment does not present unnecessary challenges that may inhibit the health and performance of chicks during grow-out.

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