EFFECTS OF HIGH–OIL CORN AND SOYBEAN OIL ADDITIVES ON DUSTINESS OF GROUND CORN AND FEED

A. J. Heber

ABSTRACT: Aerial dust originating from feed is a major contributor to poor air quality in swine confinement buildings. Studies have shown that addition of fats and oils to swine feed reduces its dustiness. The objective of this study was to evaluate the effectiveness of several high–oil corn (HOC) varieties on reducing aerodynamic dust segregation (ADS) as compared with conventional or normal corn (NC) as ground corn only and also as the base ingredient of typical feed rations. Comparisons were also made between HOC–based feed with NC–based feed with 0.5% to 2.0% soybean oil. Experiments were conducted using a laboratory apparatus designed to measure ADS based on both mass (ADSₘ) and number (ADSₙ). The ADSₘ was defined as the percentage of mass lost by entrainment into the air by dropping a sample through a vertical tube. The ADSₙ was defined as the particle number concentration in a 235–mL air sample drawn from the tube 100 s after dropping the ground corn or feed sample. One of the single–cross HOC varieties produced only 19% (P < 0.05) of the ADSₘ of a NC variety and only 27% to 28% of the TopCross HOC varieties. Feed with the single–cross HOC was significantly less dusty than NC–based feed. The ADSₙ of feed with HOC was not significantly different from that of feed with NC amended with soybean oil.

Keywords. Aerosol particles, Airborne dust, Particle analysis, Particulate matter, Rations.

One of the challenges facing livestock producers is poor air quality in animal confinement buildings. High concentrations of suspended particles originating from feed are a major contributor to high dust levels (Heber et al., 1988). Studies have shown that addition of fats and oils to feed reduces the generation of dust in confinement buildings (Chiba et al., 1985; Jericho and Harries, 1975; Gore et al., 1986). Research has shown that liquid animal fat concentration in feed needs to be twice as high as that of SBO to achieve similar ADS. An increase in liquid animal fat concentration in feed needs to be twice as high as that of SBO to achieve similar ADS. An increase in MC from 9% to 12% produced a 22% decrease in ADS. Corn–based feed was 12.3% less dusty than sorghum–based feed. The most popular HOC technology is TopCross (TC), which is licensed by DuPont Specialty Grains (Johnston, Ore.), and a custom–designed single–jet impactor (fig. 3) were used for this experiment. The particle analyzer and the shutters of the ADS tester were computer controlled to eliminate timing errors.

Mass ADS

Aerodynamic dust segregation (ADS) was defined by Heber and Martin (1988) as the mass of separated fine particles remaining in a 1.0–m high, 5.0–cm diameter column 1.0 s after dropping a 10–g sample of powder–type material (e.g., ground feed) through the column (fig. 2). The ADS tester was designed to simulate particle segregation that occurs when feed is handled. It functioned with a standard 35–mm film container that easily held 10 to 15 g of material. The plastic container had a lip that sealed against an O–ring at the lower end of the column. In this experiment, the mass of each grab subsample from the ground material was 12 g ±0.5 g. Computer–controlled solenoids opened and closed shutters at the top and bottom of the column (fig. 2). Before dropping the sample, the top opening of the column was sealed shut with a rubber stopper. The top shutter dropped the preweighed sample, which fell past the opened shutter at the bottom of the tube into the empty container. The bottom shutter closed after 1.0 s, preventing any airborne particles remaining in the column from settling into the container. The...
Figure 1. Aerodynamic dust segregation tester. Components are shown in figures 2 and 3.

Figure 2. Schematic of aerodynamic dust segregation tester.

Figure 3. Two-stage impactor. All dimensions in mm. Dimension X was 12.70 and 9.86 mm and dimension Y was 6.35 and 4.93 mm for stages 1 and 2, respectively. The cutoff diameters were 10.0 and 7.07 µm for stages 1 and 2, respectively.

collection of the 236 mL air sample began 100 s after the top shutter opened. Air from the column flowed through a 20 to 33 cm long, 6.4-mm inside diameter Tygon tube to a two-stage cascade impactor that removed large particles that could contaminate the particle analyzer. The nominal cutoff diameters of the first and second stages were 10.0 and 7.07 µm, respectively. The impaction plates were coated with Vaseline petroleum jelly to prevent particle bounce. The plates were cleaned and recoated before each test.

The impactor outlet was attached directly to the particle analyzer inlet (fig. 1). The particle analyzer had six channels with lower size limits of 0.5, 0.9, 1.6, 2.8, 5.0, and 10.0 µm, respectively. An air sample was drawn to determine background concentration prior to dropping the corn or feed sample. The particle analyzer was turned off and the tube removed from the sampling port on the column. To prevent large particles from entering the tube through the port as the sample fell past it, a steel bolt was inserted into it before dropping the sample. The particle analyzer was started at 75 s and the tube was inserted at 97 s, or 3 s before it started counting particles. Residues of deposited and airborne dust inside the column were blown out with compressed air after each test.

Net concentrations were determined by subtracting the background concentration from the gross concentration. However, excessive variability and noise occurred in the 0.5 and 0.9 µm channels. Gross concentration of all particles greater than 1.6 µm appeared to be the most meaningful and was therefore used as the dependent variable.
**EXPERIMENTAL DESIGN**

Laboratory experiments were conducted to evaluate the effectiveness of several corn varieties on reducing ADS of ground corn and feed (tables 1 and 2). Test A involved four corn varieties denoted NC_A, TC, X-A, and X-B. The TC variety was dried at low (TC-L) and high (TC-H) temperatures. High-oil corn varieties were compared with normal corn (NC) in experiments with ground corn (part 1) and swine-finishing feed (part 2). Test B compared single-cross HOC with NC in ground corn and ground feed and involved three corn varieties denoted X-C, X-D, and NC_B (table 2). Test B also compared HOC-based feed with NC-based feed amended with 0.5% to 2.0% SBO.

Four 500-g lots were prepared for each treatment. Each ground lot was placed in a 1.05-L jar and tested for ADS, MC, and particle size distribution, which required about 50, 5, and 25 g, respectively. Four ADS tests were conducted on each lot, for a total of 16 runs per treatment. The ADS tests in each part (test A part 1, test A part 2, and test B) were conducted in randomized order; thus, four tests of subsamples from any one lot were not conducted consecutively.

**SAMPLE PREPARATION**

Corn and feed mixtures were ground with a 4.8-mm screen in a laboratory-scale hammer mill, which was expected to provide a particle size reduction comparable to commercial mills. The hammer mill was brought to full speed before dumping a 500-g lot of feed mixture or corn into the hopper and pulling its trap door. The mill’s feed wheel was rotated manually in test A and automatically in test B at about 20 rpm. A special funnel directed the ground corn by gravity from the hammer mill outlet into a 3.8-L can with a minimal loss of fine particles. About 50% of the sample remained outside the screen in the hammer mill housing and was brushed into the outlet after each sample was ground. The sample was then poured from the can into a jar. Each lot was ground individually in random order within each test. The hammer mill was thoroughly cleaned with compressed air after grinding each lot. Each lot of ground corn was mixed with a cross-flow mixer for 60 s, and each lot of ground feed was mixed for 10 min. All feed ingredients (including SBO for treatments L3, M3, and H3) were weighed with 0.1-mg resolution and poured into a jar that was manually shaken to attain uniformity before grinding. The percentages of swine feed ingredients were as follows:

- Whole corn: 75.85%
- Soybean meal: 20.85%
- Dicalcium phosphate: 1.40%

### Table 1. Varieties of corn tested.

<table>
<thead>
<tr>
<th>Test</th>
<th>Designation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>NC_A</td>
<td>Normal corn (LH122 × LH5152)</td>
</tr>
<tr>
<td></td>
<td>TC–L</td>
<td>TopCross HOC dried at low temperature</td>
</tr>
<tr>
<td></td>
<td>TC–H</td>
<td>TopCross HOC dried at high temperature</td>
</tr>
<tr>
<td></td>
<td>X–A</td>
<td>Composite of single-cross (X122) HOC from Illinois and Indiana</td>
</tr>
<tr>
<td></td>
<td>X–B</td>
<td>Composite of single-cross (X122) HOC from Kansas and Nebraska</td>
</tr>
<tr>
<td>B</td>
<td>X–C</td>
<td>Single-cross HOC (LH192 × LP26)</td>
</tr>
<tr>
<td></td>
<td>X–D</td>
<td>Single-cross HOC (LH197 × LP11)</td>
</tr>
<tr>
<td></td>
<td>NC_B</td>
<td>Normal corn (LH132 × LP11)</td>
</tr>
</tbody>
</table>

### Table 2. Experimental design and data summary.

<table>
<thead>
<tr>
<th>Treatment[a]</th>
<th>Corn</th>
<th>MC[b] (%)</th>
<th>C (%)</th>
<th>MMD (µm)</th>
<th>GSD</th>
<th>ADSn[c] (%)</th>
<th>ADSn[c] (particles mL⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test A: Ground corn (part 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>NC_A</td>
<td>8.3 ±0.19</td>
<td>0</td>
<td>803</td>
<td>198</td>
<td>6.4 ±0.4</td>
<td>28.89 ±7.97</td>
</tr>
<tr>
<td>G1</td>
<td>NC_A</td>
<td>10.4 ±0.05</td>
<td>0</td>
<td>722</td>
<td>192</td>
<td>6.9 ±0.6 B</td>
<td>18.90 ±10.72 A</td>
</tr>
<tr>
<td>G2</td>
<td>TC–L</td>
<td>7.1 ±0.13</td>
<td>0</td>
<td>664</td>
<td>193</td>
<td>7.2 ±0.9 AB</td>
<td>12.84 ±8.62 A B</td>
</tr>
<tr>
<td>G3</td>
<td>TC–H</td>
<td>9.2 ±0.23</td>
<td>0</td>
<td>641</td>
<td>193</td>
<td>8.5 ±1.1 A</td>
<td>13.69 ±2.82 A B[d]</td>
</tr>
<tr>
<td>G4</td>
<td>X–A</td>
<td>10.8 ±0.12</td>
<td>0</td>
<td>773</td>
<td>194</td>
<td>4.9 ±0.3 C</td>
<td>3.63 ±0.66 B</td>
</tr>
<tr>
<td>G5</td>
<td>X–B</td>
<td>7.6 ±0.11</td>
<td>0</td>
<td>758</td>
<td>191</td>
<td>4.8 ±0.3 C</td>
<td>3.60 ±1.64 B</td>
</tr>
<tr>
<td>Test A: Ground feed (part 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F1</td>
<td>NC_A</td>
<td>9.6 ±0.15[c]</td>
<td>0</td>
<td>737</td>
<td>191</td>
<td>6.7 ±0.3 B</td>
<td>27.58 ±4.83 A</td>
</tr>
<tr>
<td>F2</td>
<td>TC–L</td>
<td>7.3 ±0.15[c]</td>
<td>0</td>
<td>684</td>
<td>189</td>
<td>7.5 ±0.3 A</td>
<td>27.59 ±5.46 A</td>
</tr>
<tr>
<td>F3</td>
<td>TC–H</td>
<td>3.8 ±0.11</td>
<td>0</td>
<td>681</td>
<td>187</td>
<td>7.2 ±0.5 AB</td>
<td>11.35 ±3.00 B</td>
</tr>
<tr>
<td>F4</td>
<td>X–A</td>
<td>6.3 ±0.12[c]</td>
<td>0</td>
<td>755</td>
<td>192</td>
<td>5.7 ±0.6 C</td>
<td>7.74 ±2.85 B</td>
</tr>
<tr>
<td>Test B: Ground corn and feed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G6</td>
<td>X–C</td>
<td>13.2 ±0.12</td>
<td>0</td>
<td>755</td>
<td>192</td>
<td>5.0 ±0.3 BC</td>
<td>0.98 ±0.40 B</td>
</tr>
<tr>
<td>G7</td>
<td>X–D</td>
<td>13.2 ±0.11</td>
<td>0</td>
<td>730</td>
<td>189</td>
<td>5.3 ±0.3 AB</td>
<td>0.88 ±0.10 B</td>
</tr>
<tr>
<td>G8</td>
<td>NC_B</td>
<td>13.0 ±0.32</td>
<td>0</td>
<td>728</td>
<td>189</td>
<td>5.5 ±0.5 A</td>
<td>2.48 ±0.21 A</td>
</tr>
<tr>
<td>F6</td>
<td>X–C</td>
<td>12.9 ±0.30</td>
<td>0</td>
<td>682</td>
<td>185</td>
<td>4.5 ±0.4 D</td>
<td>0.94 ±0.31 B</td>
</tr>
<tr>
<td>F7</td>
<td>X–D</td>
<td>12.8 ±0.14</td>
<td>0</td>
<td>665</td>
<td>187</td>
<td>5.1 ±0.4 ABC</td>
<td>1.00 ±0.23 B</td>
</tr>
<tr>
<td>F8</td>
<td>NC_B</td>
<td>12.7 ±0.48</td>
<td>0</td>
<td>668</td>
<td>186</td>
<td>5.3 ±0.4 AB</td>
<td>2.64 ±0.73 A</td>
</tr>
<tr>
<td>L8</td>
<td>NC_B</td>
<td>12.6 ±0.16</td>
<td>0.5</td>
<td>669</td>
<td>186</td>
<td>4.8 ±0.3 CD</td>
<td>0.91 ±0.10 B</td>
</tr>
<tr>
<td>M8</td>
<td>NC_B</td>
<td>12.8 ±0.34[c]</td>
<td>2.0</td>
<td>674</td>
<td>186</td>
<td>4.0 ±0.2 E</td>
<td>0.59 ±0.10 B</td>
</tr>
<tr>
<td>H8</td>
<td>NC_B</td>
<td>12.8 ±0.11[c]</td>
<td>1.0</td>
<td>683</td>
<td>186</td>
<td>3.9 ±0.5 E</td>
<td>0.66 ±0.15 B</td>
</tr>
</tbody>
</table>

[a] G and F denote ground corn and feed, respectively.
[b] Means are given with the 95% confidence interval.
[c] Means are given with the 95% confidence interval based on lot means within treatment except for C1, which was based on 10 subsamples from one lot. Means with the same letter (within each category of tests) are not significantly different based on Duncan’s multiple range test.
[d] The least significant difference method resulted in A grouping only.
[e] One outlier removed from set of four samples.
Limestone: 0.95%  
Stock salt: 0.50%  
Vitamin premix: 0.25%  
Trace mineral: 0.10%  
Antibiotics: 0.10%  
Total: 100%

Soybean oil content was based on the mass of SBO required to achieve target contents of 0.5%, 1.0%, and 1.5%.

**MOISTURE CONTENT AND PARTICLE SIZE DISTRIBUTION**

The MC of each lot was determined by drying about 5 g of sample at 130°C for 60 min (ASAE Standards, 2000). The samples were weighed on a digital balance with 0.1–mg resolution. The particle size distribution was determined using a standard sieving procedure (ASAE Standards, 1984). A composite 100–g subsample of each treatment consisting of 25 g per lot was classified by particle size using U.S. Sieves 12, 16, 20, 30, 40, and 50 with openings of 1608, 1190, 840, 591, 420, and 297 μm, respectively. The mean mass diameter (MMD) and geometric standard deviation (GSD) were calculated using equations 1 and 2, respectively:

\[
\log \text{MMD} = \frac{\sum_{i=1}^{k} W_i \log d_i}{\sum_{i=1}^{k} W_i} \quad (1)
\]

\[
\log \text{GSD} = \left[ \frac{\sum_{i=1}^{k} W_i (d_i - \text{MMD})^2}{\sum_{i=1}^{k} W_i} \right]^{0.5} \quad (2)
\]

**STATISTICAL ANALYSIS**

The four lots of each treatment were prepared separately, thus introducing a source of variance (s²) among lots within corn variety due to grinding and mixing. Four subsamples from each lot were tested with the ADS tester in an identical manner, and the variance (s²) among these subsamples was determined to assess sampling error. The tests of significance in the statistical analysis utilized the “lot within treatment” source of variance for the experimental error.

The variance of each dependent variable among the 16 samples of each treatment in test B was visually observed for normality. Duncan’s multiple range test (Steel and Torrie, 1980) was performed for the five treatments in test A part 1, the four treatments in test A part 2, and the nine treatments in test B.

**RESULTS**

**MOISTURE CONTENT**

Table 2 summarizes the experimental data. In test A part 1, the mean MC values (%, wet basis) and the 95% confidence intervals of the ground corn samples were 10.4 ± 0.05, 7.1 ± 0.13, 9.2 ± 0.23, 10.8 ± 0.12, and 7.6 ± 0.11 for treatments G1, G2, G3, G4, and G5, respectively. In test A part 2, the mean MC values of the feed samples were 9.6 ± 0.15, 7.3 ± 0.15, 3.8 ± 0.11, and 6.3 ± 0.12 for treatments F1, F2, F3, and F4, respectively. Since MC influences ADS (Heber and Martin, 1988) and the control corn had higher MC than G2, G3, and G5, it was dried to 8.3% ± 0.19% to create a moisture-adjusted version of G1 referred to as C1. The effect of adjusting MC after grinding and not before grinding is unknown.

In test B, the MC values of the ground corn samples were 13.0% to 13.2%, while the MC values of the ground feed samples were 12.6% to 12.9%, respectively. The MC among treatments had much greater uniformity in test B as compared with test A.

**PARTICLE SIZE DISTRIBUTION**

In test A, the MMD values were 722, 664, 641, 773, and 758 μm for ground corn treatments G1, G2, G3, G4, and G5, respectively. The geometric standard deviation was about 1.9 for all samples (table 2). Treatment C1 had an MMD of 803 μm; thus, drying of G1 apparently increased particle size. The reasons for increased particle size with MC are not known, and the difference could not be tested statistically with only one sample of each lot.

The MMD values of ground feed treatments F1, F2, F3, and F4 were 737, 684, 681, and 755 μm, respectively. Although smaller particle sizes were expected with feed, the MMD of feed samples were similar to those of ground corn. The difference in MC among treatments may have contributed to similarities in particle size distributions.

In test B, treatments G6, G7, and G8 had the largest MMDs (755, 730, and 728 μm, respectively). As a result of adding feed ingredients, MMD values decreased to 682, 665, and 668 μm in treatments F6, F7, and F8, respectively. The MMDs of treatments L8, M8, and H8 were 669, 674, and 683 μm, respectively, showing a trend of only slightly larger MMDs with higher oil content (table 2).

**AERODYNAMIC DUST SEGREGATION, TEST A**

**Ground Corn**

The ADSₘ values ranged from 4.8% to 8.5% for ground corn in the comparison of TopCross and single-cross varieties of HOC with treatment G1 (normal corn, NCₐ) (tables 1 and 2). The mean ADSₘ values of treatments G4 and G5 (single-cross HOC) were 29% and 31%, less (P < 0.05) than G1, but surprisingly, the mean ADSₘ of treatment G3 (TC–H) was 22% greater than G1 (P < 0.05). Treatments G2 (TC–L) and G1 were not significantly different. Thus, the single-cross HOC varieties were effective in reducing ADSₘ, while the TopCross varieties had no apparent effect.

Each of the single-cross HOC varieties (G4 and G5) had 81% less (P < 0.05) ADSₘ than G1 (table 2). They had only 28% and 26% (P < 0.05) of the ADSₘ values measured with TopCross HOC (G2 and G3), which were about 30% less but not significantly different (P > 0.05) from G1.

The lack of significant differences between TopCross HOC varieties and NCₐ may have been due to the differences in MC among treatments. The MC of NCₐ was 10.4%, as compared with 7.1% and 9.2% for the two TopCross HOC varieties (mean = 8.2%). The relatively low MC of the TopCross varieties as compared with NCₐ may have confounded the comparisons by contributing to higher ADSₘ and ADSₜ.

A 53% larger mean ADSₜ of 28.9 particles mL⁻¹ was obtained from 10 samples of one lot of G1 dried by 2.1 percentage points down to 8.3% MC (C1), but ADSₜ was 8% lower. However, the differences between G1 and C1 were not significant (P > 0.05). The 95% confidence interval of ADSₜ for C1 (table 2) was based on the ten subsamples within this lot. The 95% confidence intervals of all other varieties were calculated from four lot means. The standard error of
the lot means for C1 was assumed to be equal to the calculated standard error for G1. With this assumption, the ADSn values for G2 and G3 were 53% to 56% less than the ADSn for C1 (P < 0.05).

**Ground Feed**

In the ground feed study, the mean ADSm values of treatments F1, F2, F3, and F4 were 6.7 ±0.3, 7.5 ±0.3, 7.2 ±0.5, and 5.7 ±0.6, respectively (table 2). As in the ground corn study, single–cross HOC had a significant effect (P < 0.05) on ADSm (15% lower), while TopCross HOC did not reduce ADSm significantly.

The mean ADSn from F4 (single–cross HOC) was 72% less than that of F1 (NC A) (table 2). Of the two TopCross HOC varieties (F2 and F3), only F3 resulted in significantly less ADSn than F1, even with its low MC of 3.80% ±0.11%. Apparently, the process of high–temperature drying reduced dustiness of TopCross HOC in swine feed.

**Effect of MMD on ADSm**

ADSm is determined primarily by segregation and loss of relatively large particles, so differences can be largely explained by the particle size distribution of the ground corn and feed samples. Treatments G4 and G5 had the largest MMDs (773 and 759 µm, respectively), and G3 had the smallest (642 µm). Among all test A treatments, ADSm was inversely proportional to MMD (P < 0.05), according to the regression described by equation 3 (fig. 4):

\[ \text{ADSm} = 23.9 - 0.0242 \text{ MMD} \quad R^2 = 85\% \]  

**Aerodynamic Dust Segregation, Test B**

**Ground Corn and Feed**

ADSm values ranged from 3.9% to 5.5% in test B (table 2). The analysis of variance revealed non–significant lot–within–variety variance. Normal corn treatments G8 and F8 (NCB) produced 10% and 18% higher (P < 0.05) ADSm than treatments G6 and F6 (X–C HOC), respectively. Though the means of ADSm for NCB were greater than the means of G7 and F7 (X–D HOC), the differences were not statistically significant. The X–D HOC had 13% greater ADSm (P < 0.05) than X–C HOC with ground feed. Thus, the X–C HOC variety was more effective in reducing dust than the X–D HOC variety.

Lower ADSm was measured for each corn variety when mixed with feed (table 2), but the decrease of 11% was statistically significant (P < 0.05) for X–C HOC only. These differences, though small, were unexpected, since the MMDs were 8% to 10% smaller when mixed with feed. Although ADSm unexpectedly decreased in the feed mode for unknown reasons, only non–significant changes (~3%, 13%, and 7%) occurred with ADSn.

The ADSn of ground corn samples clearly showed that single–cross HOC produced significantly less dust than NC B (table 2). The single–cross HOC treatments produced 61% to 64% less ADSn (P < 0.05) than NC B in both the ground corn and ground feed tests. The effectiveness of HOC was more evident with ADSn as compared with ADSm.

**Ground Feed with Soybean Oil**

The SBO content (C) in NC B had a statistically significant effect (P < 0.05) on MMD of the samples, according to the regression given by equation 4:

\[ \text{MMD} = 666 + 8.08 \text{ C} \quad R^2 = 98\% \]  

The ADSm of treatment L8 (NC B with C = 0.5%) was similar to that of treatments F6 and F7 (HOC with no SBO). However, treatments M8 and H8 (NC B with C = 1.0% and 2.0%) resulted in 16.4% and 18.6% less (P < 0.05) ADSm than treatment L8, respectively, and were 11% to 24% less (P < 0.05) than F6 and F7 (table 2), respectively. Each increase in C resulted in significantly (P < 0.05) lower ADSm as C increased from 1.0% to 2.0%.

Results of the Duncan’s multiple range test are shown with the means of ADSn in table 2. The mean ADSn of treatment F8 (NC B) mixed with feed without SBO decreased from 2.64 particles mL−1 to 0.91, 0.59, and 0.66 particles mL−1 with C of 0.5%, 1.0%, and 2.0%, respectively. The nonlinear inverse relationship (P < 0.05) between ADSm and C is shown in fig. 5. The diminishing decrease in dust generation with increasing C confirmed previous research (Heber and Martin, 1988). The ADSn of treatments F6 and F7 (HOC with no SBO) was similar to treatments L8, M8, and H8 (NC B at C = 0.5%, 1.0%, and 2.0%).

**Figure 4. Mean ADSm as influenced by MMD in test A.**

**Figure 5. Effect of soybean oil content on ADSn and MMD in test B.**
CONCLUSIONS

The single–cross varieties of high–oil corn performed best and reduced dust as effectively as adding soybean oil to feed with normal corn, while the TopCross variety reduced dust significantly in swine feed only if it was dried at high temperature. Specific conclusions were as follows:

TEST A
• With ground corn, single–cross HOC exhibited 72% to 73% less ADSn than TopCross HOC, and 81% less ADSn and 30% less ADSm than normal corn, respectively (P < 0.05).
• Mean ADSn of feed with single–cross HOC was 72% lower than feed with normal corn (P < 0.05).
• Mean ADSn of feed with TopCross HOC dried at high temperature was 41% less than feed with TopCross HOC dried at low temperatures (P < 0.05) and 41% less than feed with normal corn.
• Mean ADSm was inversely related to MMD based on all feed and corn samples (P < 0.05).

TEST B
• Both single–cross HOC varieties produced 61% to 64% less ADSn than normal corn in the ground corn and swine feed studies, and one of the varieties produced 9% to 15% less ADSm than normal corn (P < 0.05).
• The application of soybean oil to NC–based swine feed resulted in up to 26% less ADSm and up to 78% less ADSn, depending on content.
• Mean ADSn of feed with single–cross HOC was similar to feed with normal corn amended with soybean oil.

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REFERENCES


ABBREVIATIONS

ADS = aerodynamic dust segregation
ADSm = ADS by mass (%)
ADSn = ADS by number, concentration of particles greater than 1.6 μm (particles mL–1)
C = soybean oil content in feed (%)
di = midpoint diameter of size interval of sieve i
GSD = geometric standard deviation, dimensionless
HOC = high–oil corn
i = sieve number
k = total number of particle size intervals
MC = moisture content (%), wet basis
MMD = geometric mass mean diameter (μm)
NC = conventional or normal dent corn
SBO = soybean oil
Wi = weight of particles retained in sieve i