Research on the impact of ozone on crops

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EPA
NAAQS Review Process

- **Integrated Review Plan (IRP):** timeline and key policy-relevant issues and scientific questions
- **Integrated Science Assessment (ISA):** evaluation and synthesis of most policy-relevant studies
- **Risk/Exposure Assessment (REA):** quantitative assessment, as warranted, focused on key results, observations, and uncertainties
- **Policy Assessment (PA):** staff analysis of policy options based on integration and interpretation of information in the ISA and REA
- **Clean Air Scientific Advisory Committee (CASAC) review**
- **Public comment**

**Workshop on science-policy issues**
- Peer-reviewed scientific studies

**EPA proposed decisions on standards**
- Interagency review
- Agency decision making and draft proposal notice

**Agency decision making and draft final notice**
- Interagency review
- Interagency review

**EPA final decisions on standards**

**Public hearings and comments on proposal**

**Public comment**
Conclusions from science reviews

• **2006 Conclusion:** Data published since the 1996 O₃ AQCD strengthen previous conclusions that there is strong evidence that current ambient O₃ concentrations cause decreased yield and/or nutritive quality in a large number of agronomic and forage crops.

• **Conclusion of 2012 draft ISA:** Evidence is sufficient to conclude that there is a causal relationship between O₃ exposure and reduced yield and quality of agricultural crops.
<table>
<thead>
<tr>
<th>Crops with ozone response functions</th>
<th>Recent crop studies (since 2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Alfalfa</td>
</tr>
<tr>
<td>Corn</td>
<td>Bean</td>
</tr>
<tr>
<td>Cotton</td>
<td>Oilseed Rape</td>
</tr>
<tr>
<td>Kidney Beans</td>
<td>Corn</td>
</tr>
<tr>
<td>Lettuce</td>
<td>Cotton</td>
</tr>
<tr>
<td>Peanut</td>
<td>Grape</td>
</tr>
<tr>
<td>Potato</td>
<td>Mustard</td>
</tr>
<tr>
<td>Soybean</td>
<td>Peanut</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Rice</td>
</tr>
<tr>
<td>Wheat</td>
<td>Soybean</td>
</tr>
<tr>
<td>Onion</td>
<td>Wheat</td>
</tr>
<tr>
<td>Rice</td>
<td>Strawberry</td>
</tr>
<tr>
<td>Oranges</td>
<td>Sugarcane</td>
</tr>
<tr>
<td>Grapes</td>
<td>Sweet Potato</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>Watermelon</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td></td>
</tr>
</tbody>
</table>
Predicted relative yield loss (12 species)
11 Soybean datasets

7 Wheat datasets

5 Cotton datasets

2 Corn datasets
Soybean across studies

- Shows coherence across OTC & FACE studies
- 7 genotypes studied at FACE from 2003 – 2008
- 11 studies & 5 genotypes in OTC from the 1980s
• Supplemental Slides
Understanding the 12-hr W126

Steps in calculating W126 value for a particular site:

1. Measure hourly ozone (O₃) concentrations for each hour within the 12 hour daylight period (8am-8pm).
2. Assign a weight to each hourly value based on concentration: lower concentrations receive less weight than higher concentrations.
3. Sum the 12 weighted hourly values to calculate a daily W126 value.
4. Repeat steps 1-3 for each day within the ozone season and then sum the daily values to calculate the monthly W126 value.
5. Identify the consecutive 3-month period whose monthly W126 values produce the highest total.
6. This total is the seasonal W126 for this site.

Example of weighting over 5-hour period:

<table>
<thead>
<tr>
<th>Hourly O₃ (ppm)</th>
<th>Weight</th>
<th>W126 (ppm-hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>0.05</td>
<td>0.11</td>
<td>0.01</td>
</tr>
<tr>
<td>0.06</td>
<td>0.30</td>
<td>0.02</td>
</tr>
<tr>
<td>0.08</td>
<td>0.84</td>
<td>0.07</td>
</tr>
<tr>
<td>0.10</td>
<td>1.0</td>
<td>0.10</td>
</tr>
</tbody>
</table>

SUM: 0.20

Daily value = Sum of values over 12 daylight hours