Causes and Management of Soybean Leaf Puckering

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What Causes Soybean Leaves to Pucker?

- Difficult to find definitive cause in every situation
- Several theories:
  1. Soybeans were exposed to a growth regulator herbicide used for weed control in corn
  2. Soybean plant is expressing a physiological response to somewhat adverse growing conditions
  3. Response is induced by a postemergence soybean herbicide application
  4. The genetic makeup of modern soybean varieties result in these symptoms, especially when exposed to trace amounts of PGR herbicides
Symptoms Affecting Soybeans

- Cupping of trifoliate leaves
- Parallel venation of leaves
- Tips of leaves are often brown
- Plants are usually stunted
Theory I: Soybeans Exposed to Plant Growth Regulator Herbicide

- Plant growth regulator herbicides i.e. 2,4-D, dicamba, clopyralid mimic plant hormones, in particular auxins
- Extremely low concentrations are physiologically active
- Degree of severity is dependent on concentration of the herbicide, plant growth stage, variety, and environmental conditions
How Do Soybeans Become Exposed to PGR Herbicides?

- Residues remaining in or on application equipment from previous applications in corn fields are detached and applied with the soybean herbicide at low concentrations
  - Most labels contain tank-cleaning procedures: Strong detergents or tank-cleaners, triple rinse equipment
- Herbicide vapors on the plant or soil surface move out of the treated area and are absorbed by soybeans (vapor drift)
  - Vapor drift is influenced by the vapor pressure of the herbicide (formulation) i.e. 2,4-D ester
- Physical drift of spray particles during the actual application process
  - TOO WINDY: should see drift pattern
**What Herbicides are Plant Growth Regulator Herbicides?**

<table>
<thead>
<tr>
<th>dicamba</th>
<th>clopyralid</th>
<th>2,4-D</th>
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<tbody>
<tr>
<td>Clarity</td>
<td>Stinger</td>
<td>Many</td>
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<tr>
<td>Banvel</td>
<td>Hornet</td>
<td>Shotgun</td>
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<tr>
<td>Distinct</td>
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<td>NorthStar</td>
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<td>Celebrity Plus</td>
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Theory II: Physiological Response to Adverse Growing Conditions

- Attempts to explain situations where leaf puckering occurs and it appears that there was no exposure to PGR herbicides either by tank-contamination or drift.
- In most cases the puckered soybeans are noticed or reported after the first time air temperatures exceed 90°.
- At this time soybeans are entering a phase of rapid development and adverse conditions may disrupt the hormonal balance within the plant.
- Currently, no data to support this theory.
Theory III: Response Induced by POST Soybean Herbicide

- Many times puckered soybeans have received a POST soybean herbicide application
  - Most cases has been a translocated herbicide
  - Many times contain some type of spray additive (COC, MSO, AMS, or 28% UAN)

a) Translocated herbicides move to the apical meristem and may disrupt the hormonal balance

b) Spray additives may remove PGR herbicide residues from application equipment – some additives make excellent tank-cleaners

c) Biuret in 28% UAN?
Response of Soybeans to Biuret

- Biuret can be a by-product in urea nitrogen sources (i.e. 28% UAN)
  - Usually < 1.0% is found in 28% UAN

- Thought that this could be contributing to the leaf puckering symptoms when 28% UAN was applied with POST soybean herbicides

- In 1989, Liebl and Wax (UI) examined this response in the field and greenhouse
  - Biuret 4 rates: 0.01 - 1.0 lb/A with 0.25% v/v NIS
  - 28% UAN 3 rates: 2.5% - 10% v/v with 0.25% v/v NIS

- Injury ranged from 1 to 15%, however symptoms were chlorosis (yellowing)

- **NO LEAF PUCKERING WAS APPEARENT!!**
Theory IV: Genetic Makeup of Modern Soybean Varieties

- Potential that newer soybean varieties are more sensitive to trace amounts of plant growth regulator herbicides, especially if there are minute amounts of these herbicides in the atmosphere.
- Potential that newer soybean varieties show different responses to diseases and insects than varieties in the past, possible interactions between them and POST soybean herbicides.
- No research at present time to prove this theory.
Bottom Line: Does Soybean Leaf Puckering Result in Yield Loss?

- Answer would probably depend on isolating the cause
  - Herbicide exposure vs. adverse environmental conditions
- What if a PGR herbicide is involved?
  - Depend on herbicide involved, concentration, soybean genetics, growth stage, and environment
- Does exposure always result in yield loss?
  - Not always
  - Literature suggests variable results

Yield (bu/A)

2,4-D Early (V4)  2,4-D Late (V8)
Banvel Early  Banvel Late

2,4-D 1X Rate: 0.5 pt/A
Banvel 1X Rate: 1 pt/A

Knuth and Wax (UI)
Currently, Riechers et al. (UI) is conducting research looking further into this soybean leaf puckering phenomenon.

Their objectives are:

- To further document injury and yield responses from common PGR herbicides
- Develop a diagnostic lab test that could be used to identify or rule out PGR herbicides as the cause for soybean leaf puckering on a cases by case basis, using molecular marker techniques

Methods:

- PGR Herbicides: Clarity, Distinct, 2,4-D, and Stinger
- Soybean Herbicides: Pursuit, Roundup UltraMax, and Flexstar
- Application timings: V3, V6, and R2
- Pioneer 93B01 Roundup Ready soybeans
Soybean Injury 14 DAT - 2001

Riechers et al. (UI)
Soybean Yield Response - 2001

Riechers et al. (UI)
Molecular Techniques to Identify PGR Herbicide Injury

Riechers et al. (UI)
What Conclusions Can Be Made About Soybean Leaf Puckering?

- No data exists to definitively explain every case of puckered soybean leaves.
- Number of ways to prevent soybean leaf puckering from PGR herbicides:
  - Proper equipment cleaning (residues in tank and on equipment)
  - Watch wind speed and be aware of surroundings (Particle and Vapor Drift)
- If a PGR herbicide is involved in soybean leaf puckering what type of yield loss is expected:
  - Many times PGR herbicides do NOT reduce soybean yield
  - Depends on herbicide involved, concentration, soybean genetics, growth stage, and environment
- Current research looks promising in developing a test to determine whether a PGR herbicide is involved.
“Soybean puckering is a physiological response of a biological organism, the severity of which may or may not be influenced by past, present, and future environmental conditions and/or the presence of a PGR herbicide, but not in every instance”