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:
  - I. Soybeans were exposed to a growth regulator herbicide used for weed control in corn
  - II. Soybean plant is expressing a physiological response to somewhat adverse growing conditions
  - III. Response is induced by a postemergence soybean herbicide application
  - IV. The genetic makeup of modern soybean varietie 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?

dicamba	clopyralid	2,4-D
Clarity	Stinger	Many
Banvel	Hornet	Shotgun
Distinct	Accent Gold	
Marksman		
NorthStar		
Celebrity Plus		

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!!**

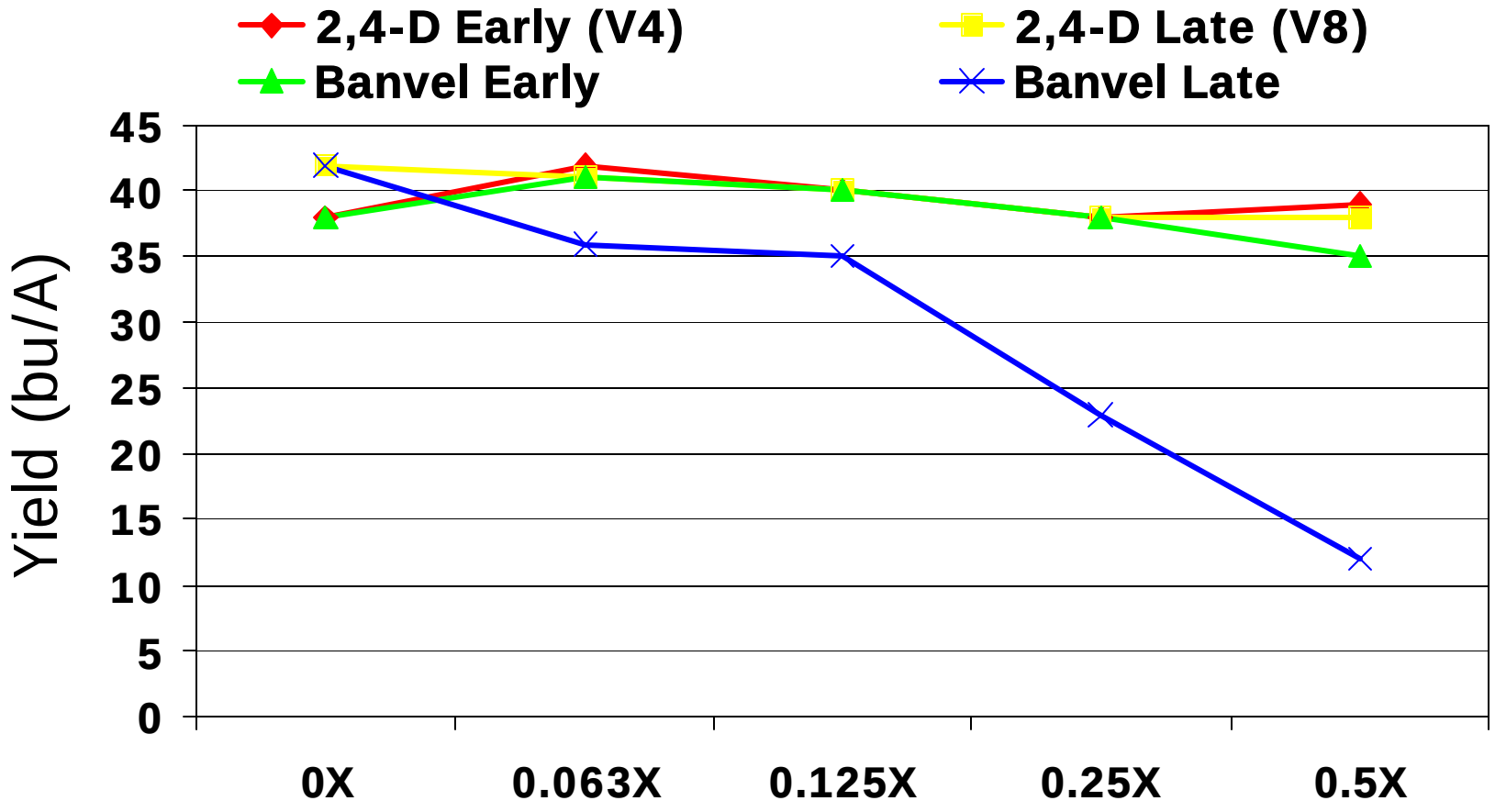
Theory IV: Genetic Makeup of Modern Soybean Varieties

- 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

Soybean Yield Response From Plant Growth Regulators – 1966 & 1967



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

Knuth and Wax (UI)

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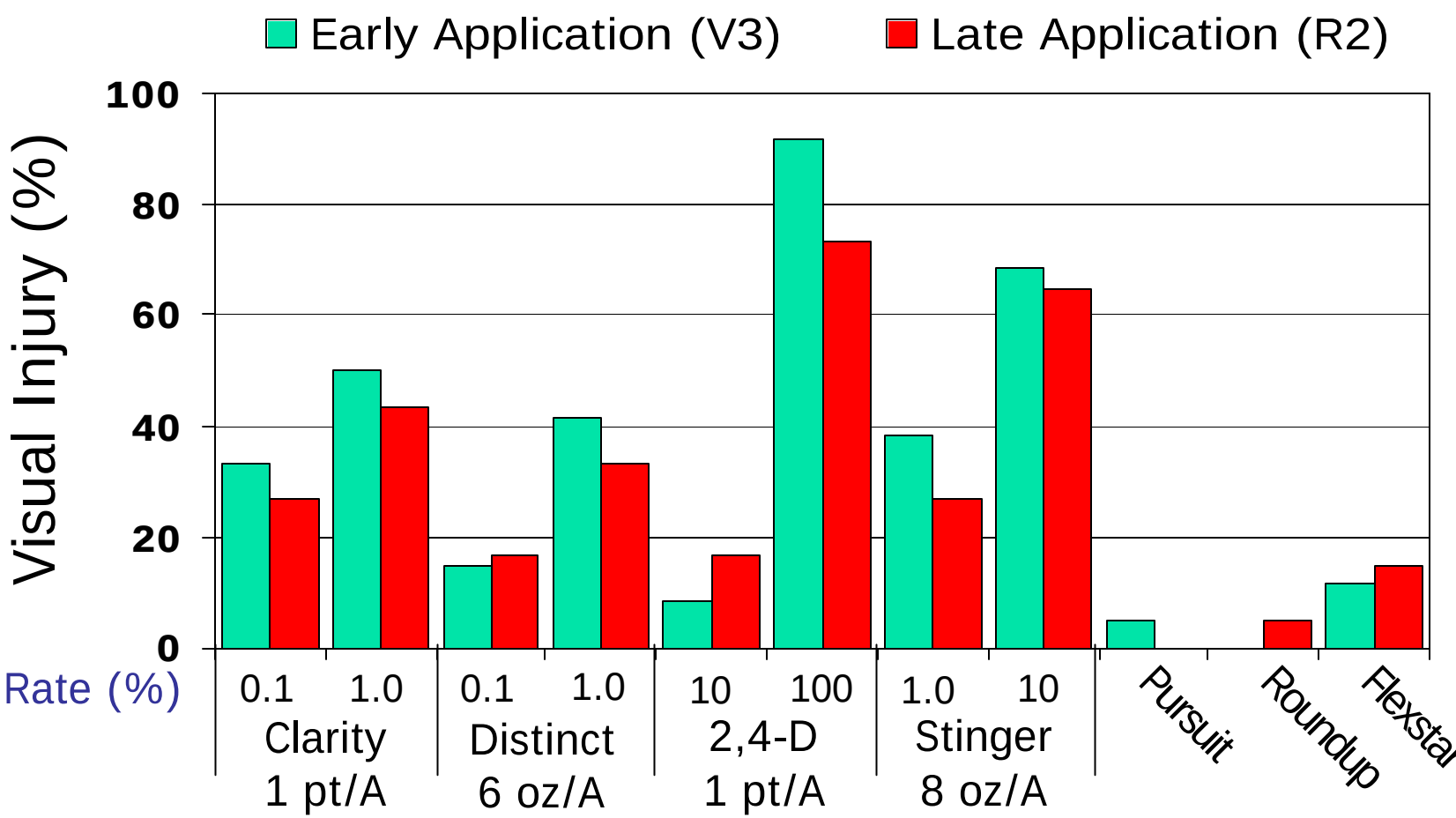
Current Soybean Response to PGR Herbicide Research

- 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 commo 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 Flexsta
  - Application timings: V3, V6, and R2
  - Pioneer 93B01 Roundup Ready soybeans

Soybean Injury 14 DAT - 2001



Riechers et al. (UI)

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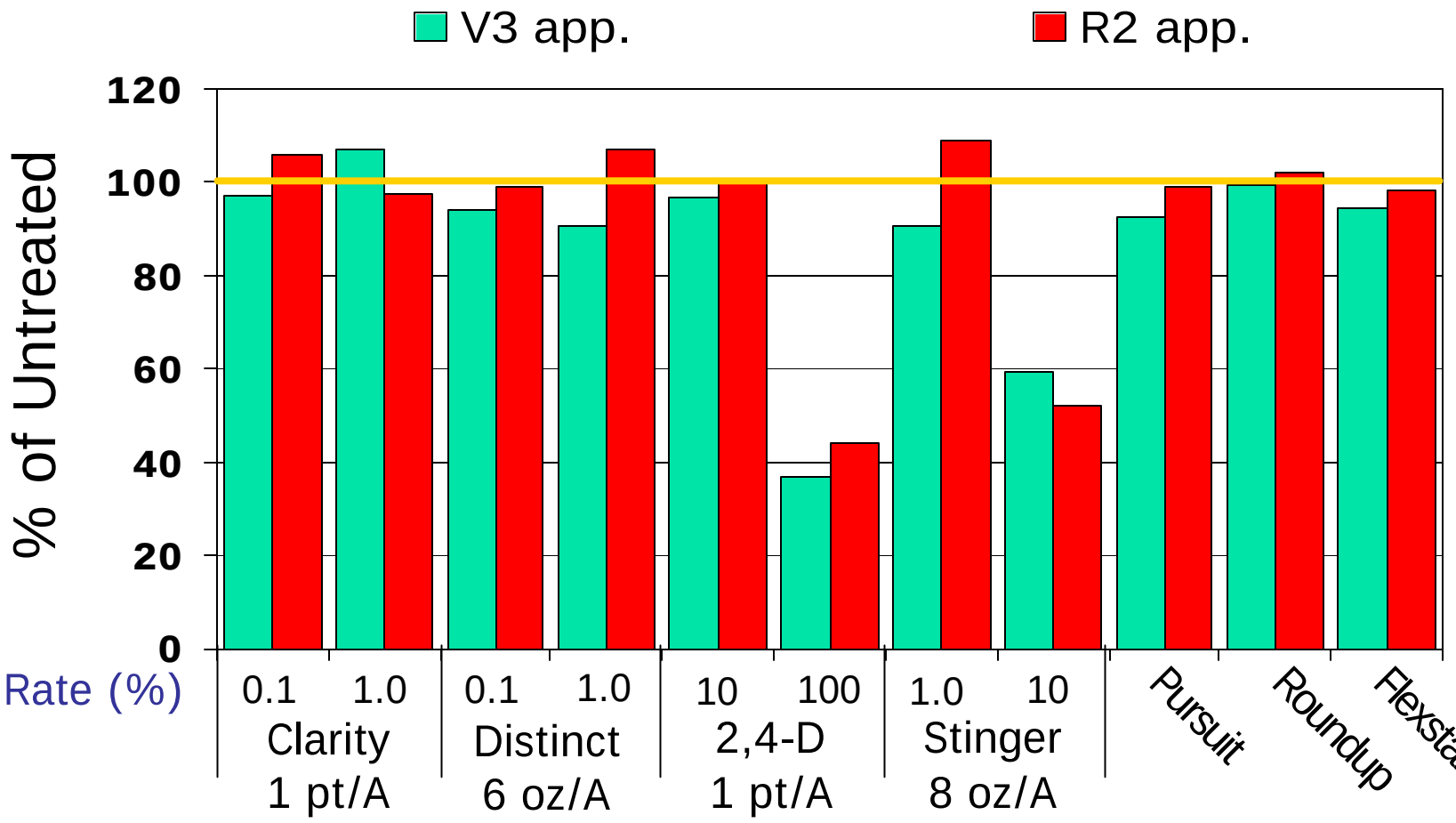
Soybean Yield Response - 2001



Riechers et al. (UI)

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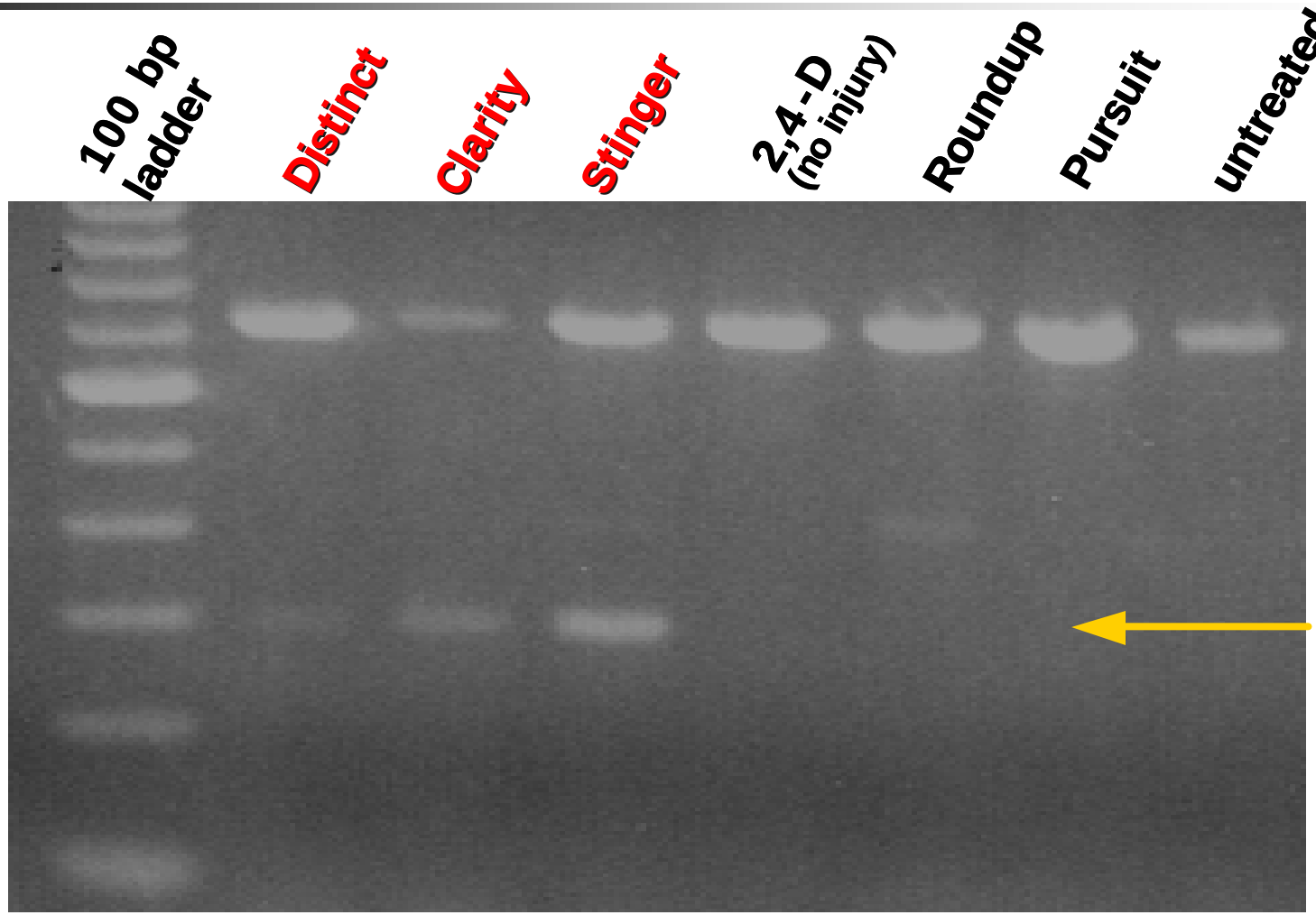
Molecular Techniques to Identify PGR Herbicide Injury



Expressio
Correlates
with
PGR
Herbicide
Injury

Riechers et al. (UI)

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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

Politically Correct Answer to the Question of Puckered Soybeans

"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" – A.G. Hager, 1998