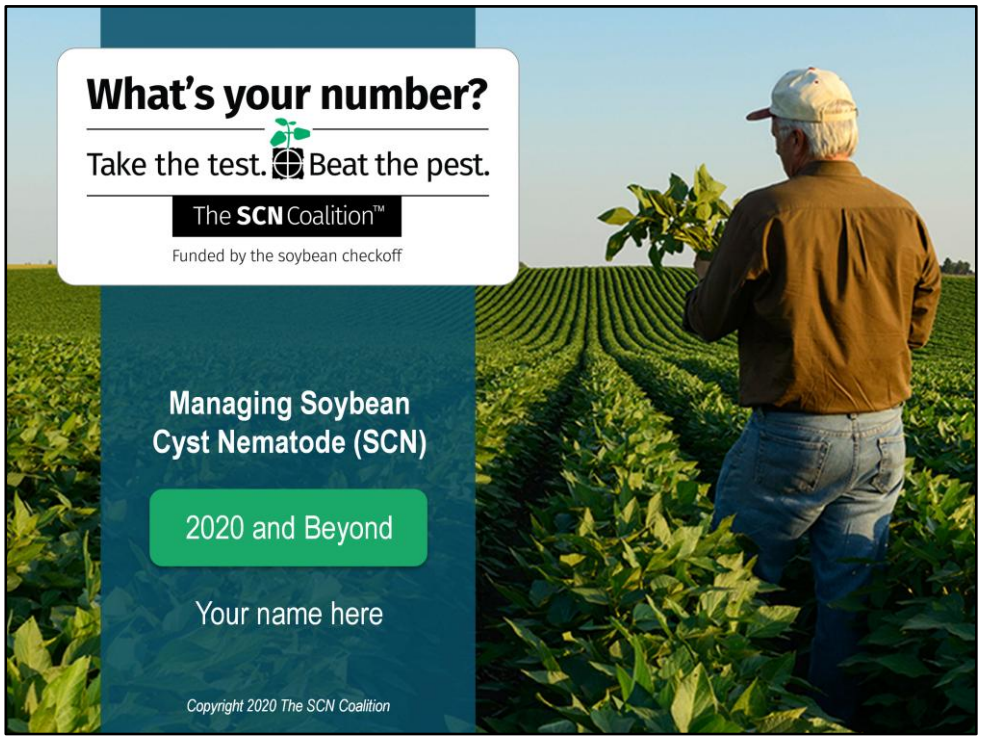
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Managing Soybean Cyst Nematode (SCN)
2020 and Beyond
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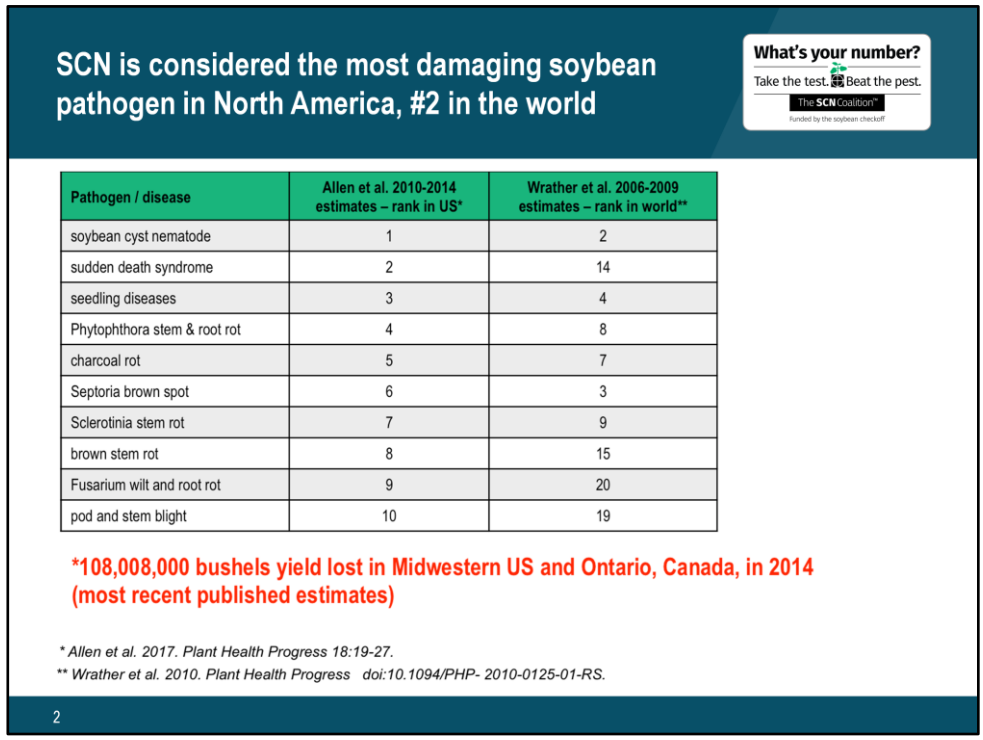
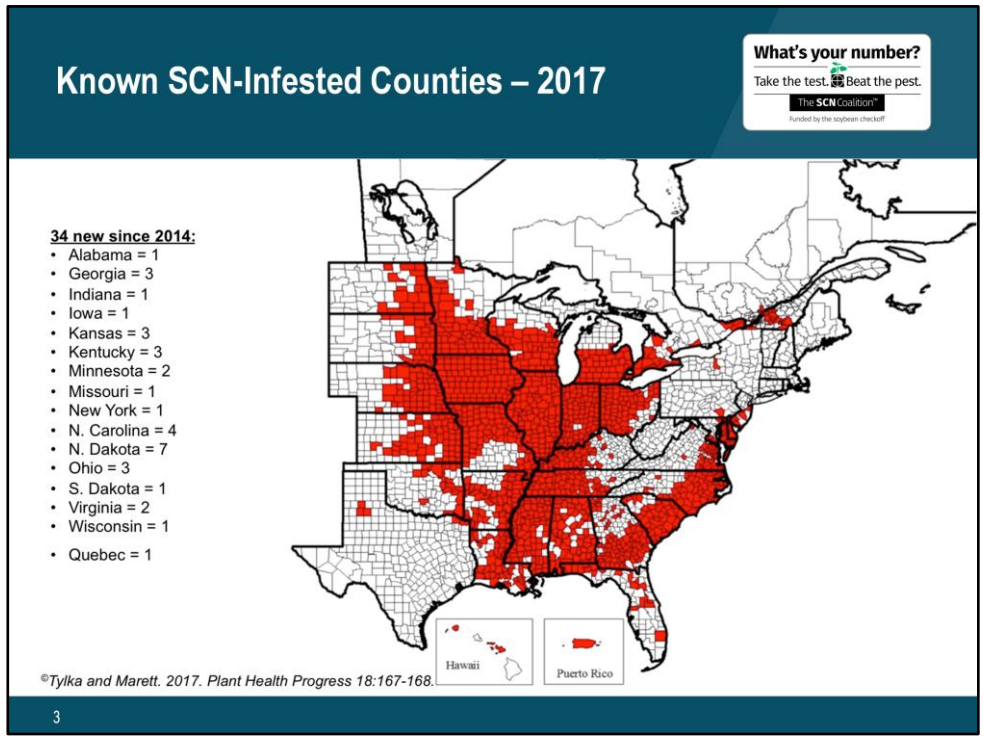


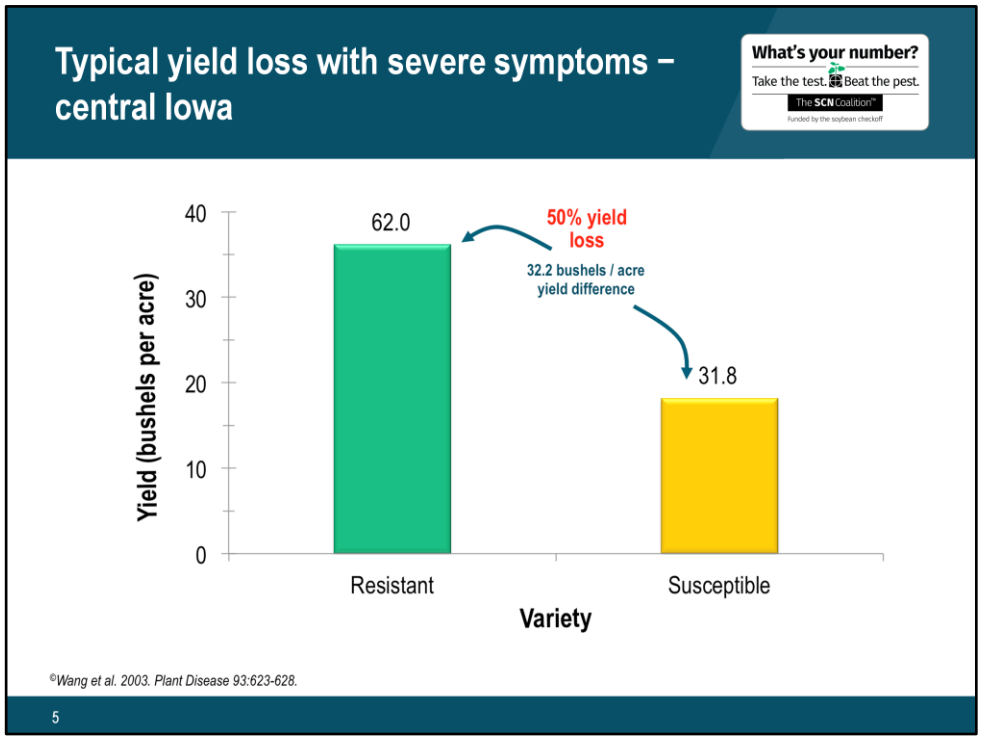
- The papers cited at the bottom of the slide are where the rankings and yield loss values on the slide come from.
- The #1 ranked soybean pathogen in the world (right-most column) is soybean rust, which did not make the top 10 list of US soybean pathogens for 2010-2014.
- If one searches online for the doi listed, they will get links to the actual publications online.



Here's the most recent map, published in 2017. There were 34 new counties found to be infested with SCN between 2014 (previous map update) and 2017. Notable points include:

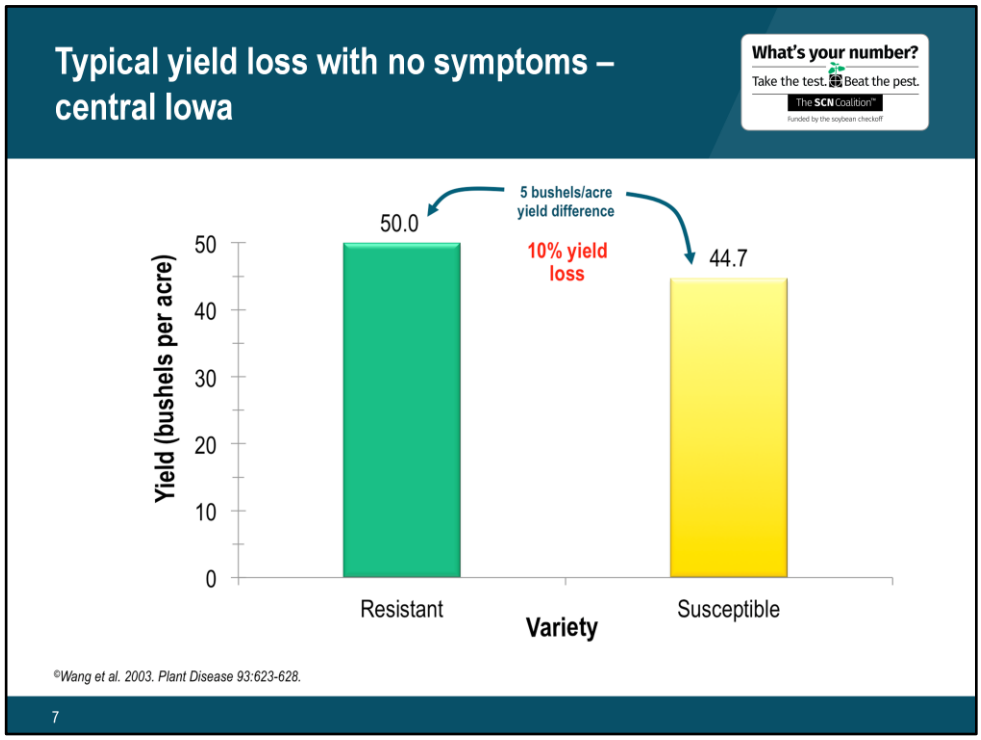
- SCN was found for first time in one county in New York. There is a significant amount of soybeans grown in New York.
- North Dakota had the most newly discovered SCN-infested counties, seven, between 2014 and 2017.

- Aerial image of severe SCN damage in a soybean field just south of Ames, IA.

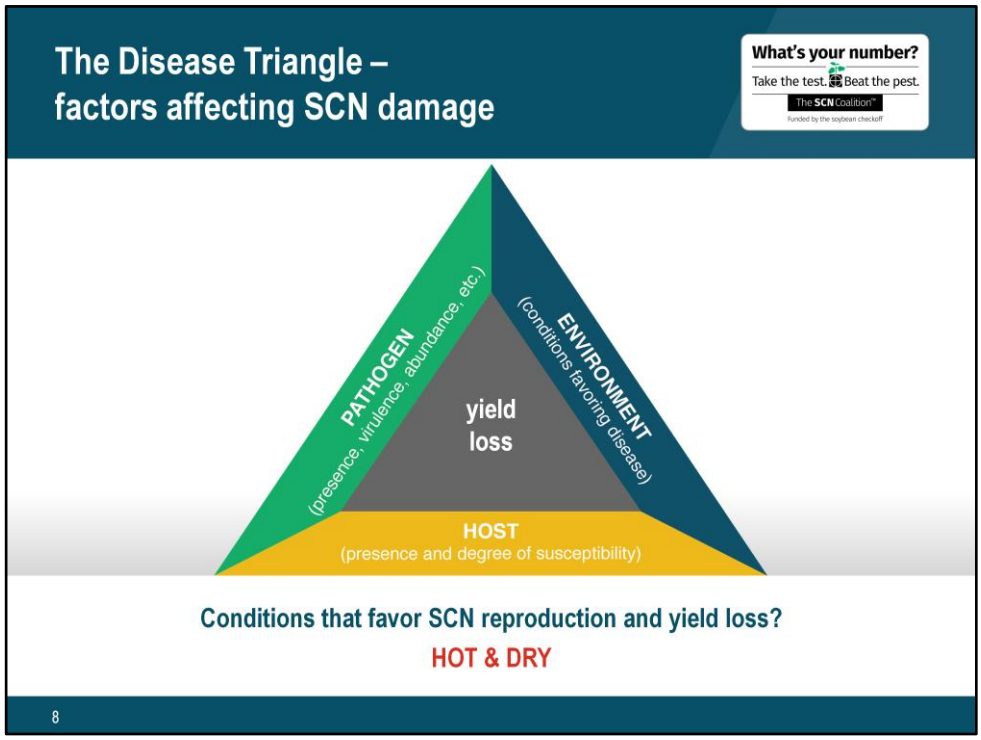


- Typical differences in yields of resistant and susceptible soybean varieties (yield loss?) in situations where severe damage is obvious above ground (like shown in previous slide).

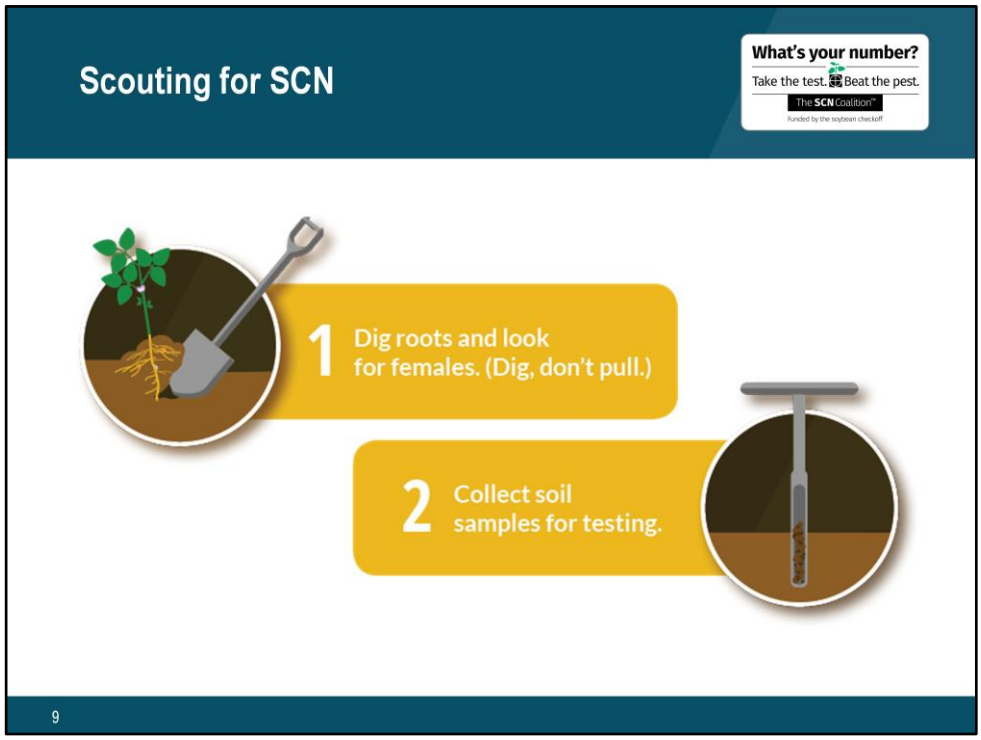
- Image of healthy-looking soybeans in an SCN-infested soybean field between Ames and Boone, IA.



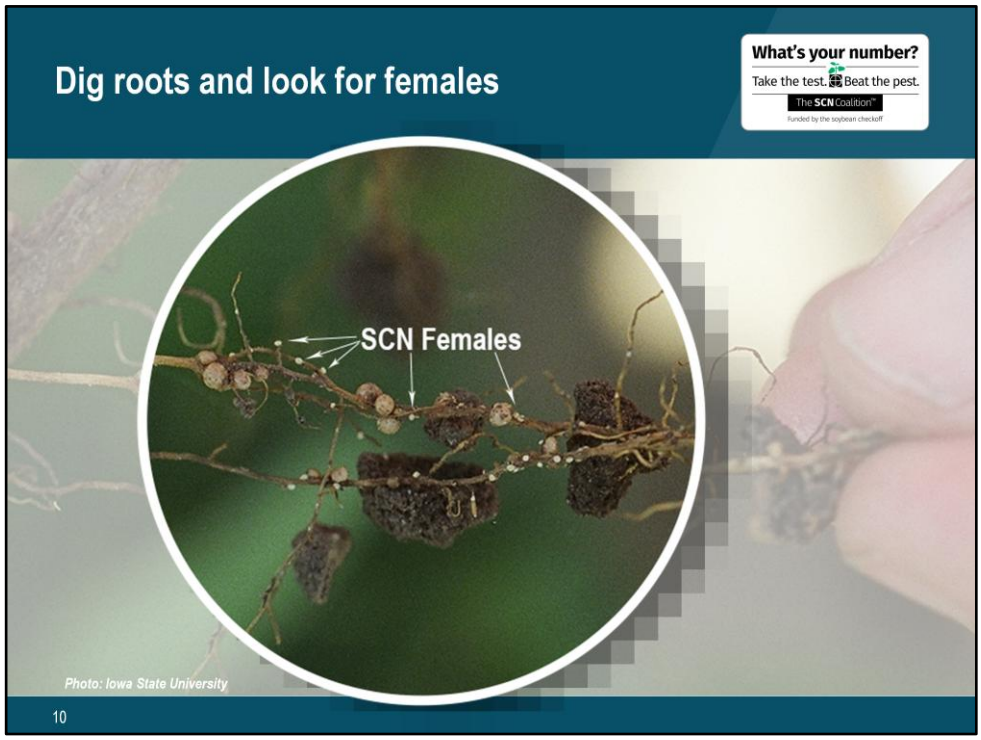
- Typical differences in yields of resistant and susceptible soybean varieties (yield loss?) in situations where no obvious above ground damage is seen (like shown in previous slide).



- The concept of the disease triangle explains the magnitude of disease that occurs and, for SCN , the magnitude of damage of **yield loss** that occurs.
- The most severe **SCN damage** and yield loss occurs in **hot, dry** conditions.



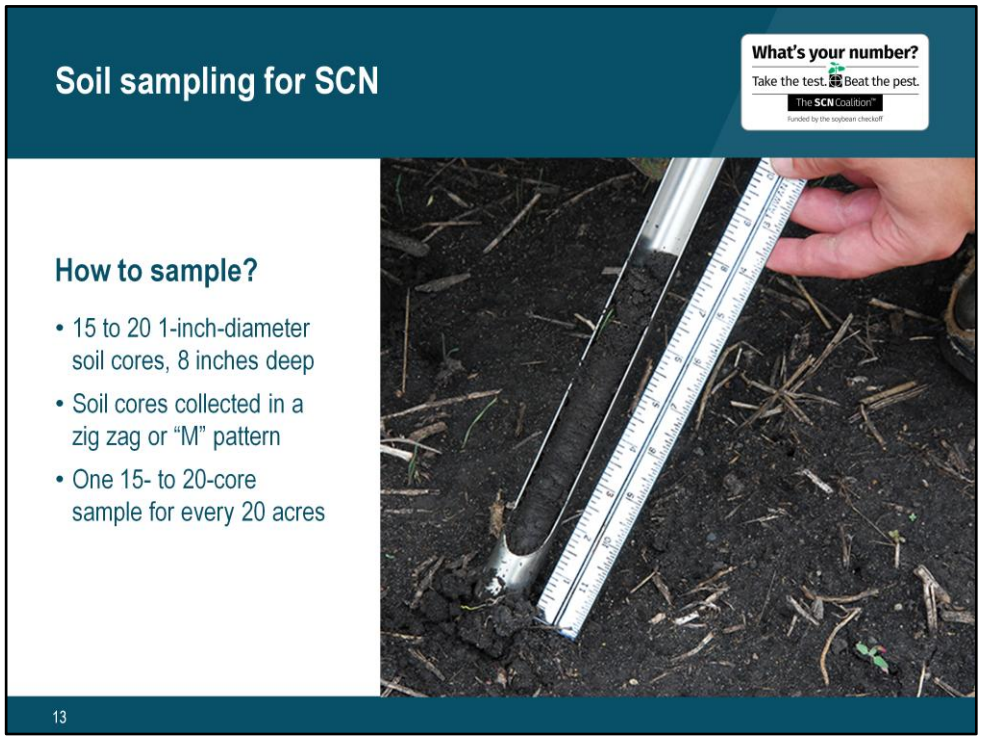
- Not seeing sick-looking plants does not mean that SCN is not present in a field.
- These are the 2 reliable ways to check for SCN.



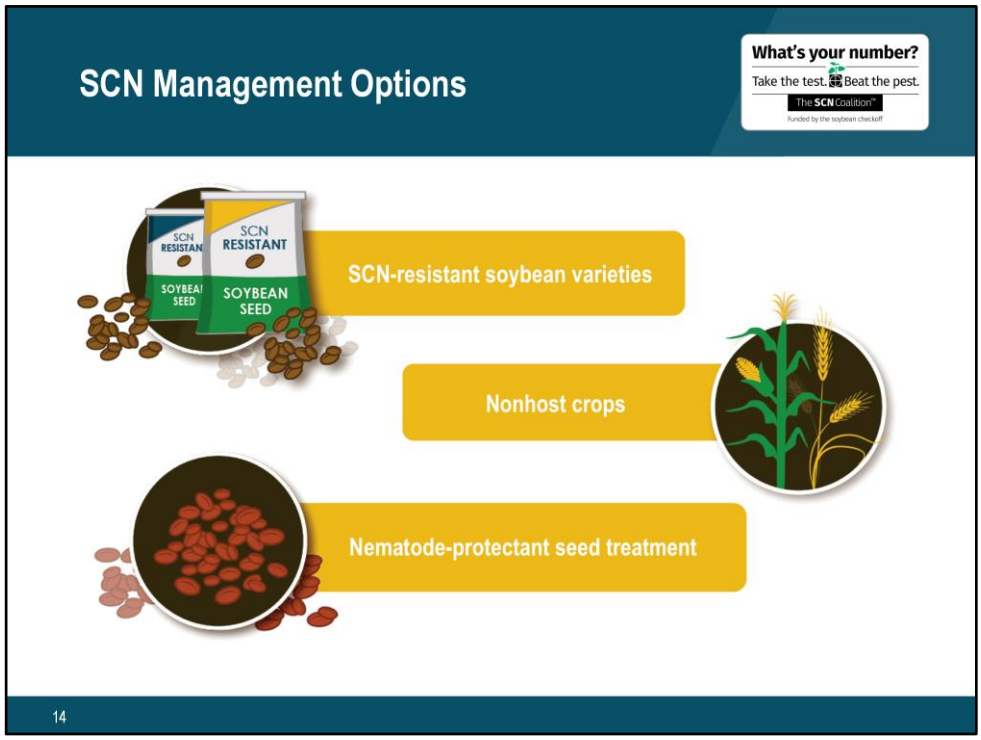
- Can start digging roots to look for SCN females about 5 to 6 weeks after planting.
- Can do this until late July/early August, after which the new roots with the new SCN females are too far down in the soil to be dug out.

- Can collect soil samples to check for SCN at any time of the year - other than when the soil is soaking wet, frozen, and/or snow covered.
- SCN soil samples can be sent to most private soil-testing labs and most land-grant or agricultural universities have nematology labs or plant disease clinics that process samples for SCN.

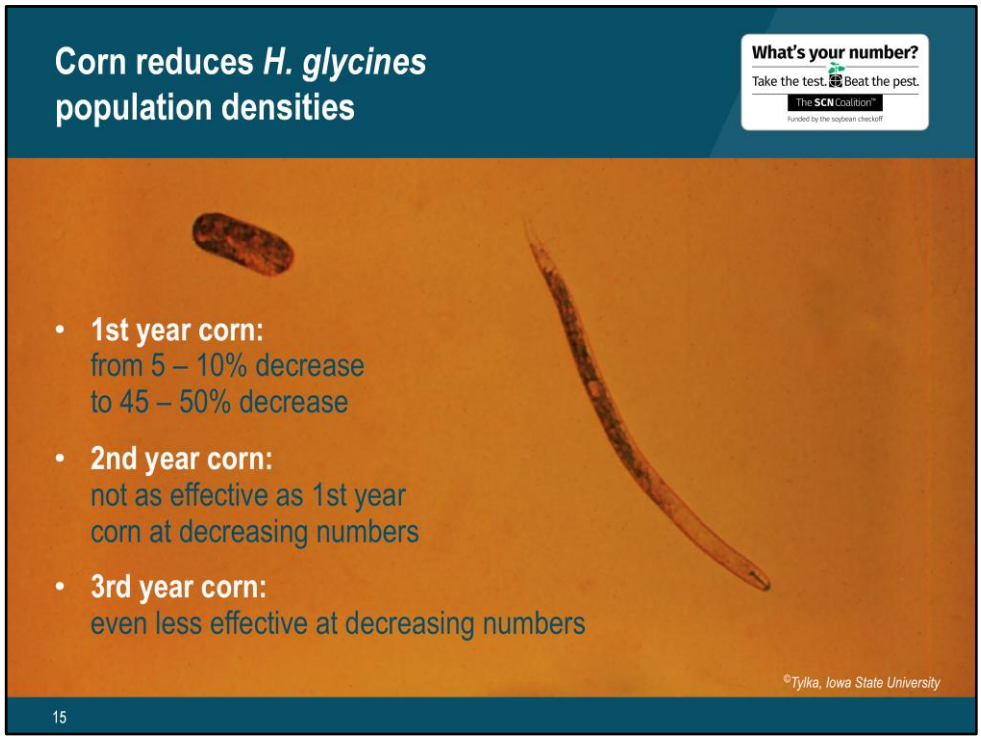
- An ideal time to collect SCN soil samples is in the fall in fields where soybeans will be grown the next growing season.
- This slide shows SCN sampling in a field after corn harvest.



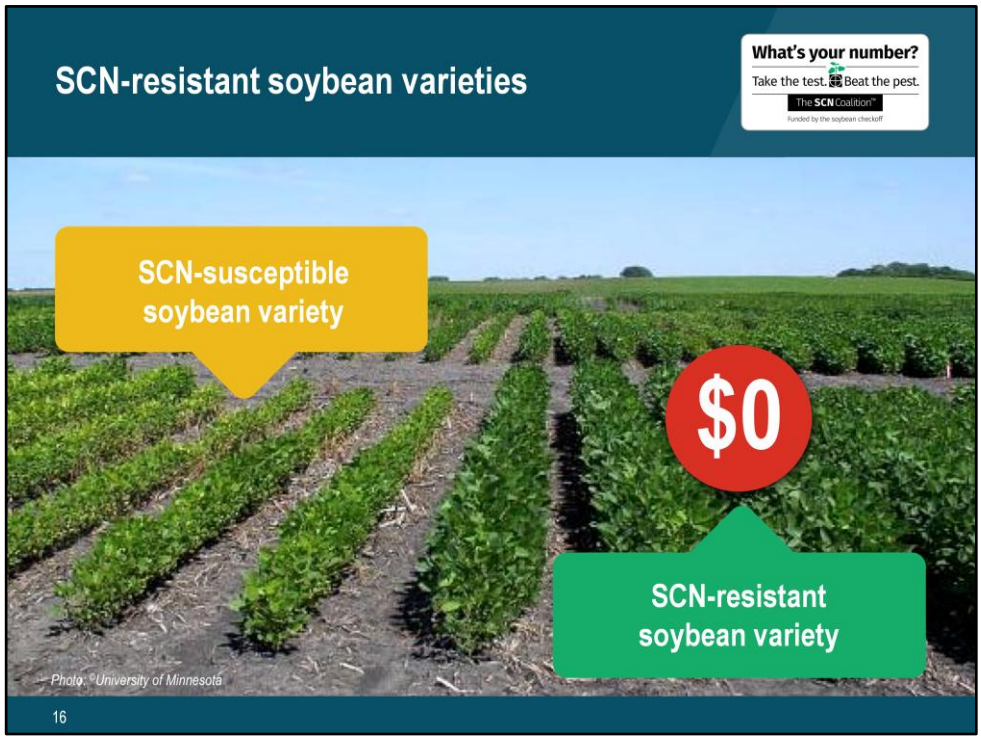
- The more soil cores collected from the smaller the area, the more reliable and accurate the results for SCN will be.
- SCN is extremely patchy in fields and can be missed in soil samples.
- Egg counts of 0 should not be considered proof that SCN is not present in the field - repeated sampling in future years before every 2nd or 3rd soybean crop is advised.



- Three categories of management strategies for SCN.



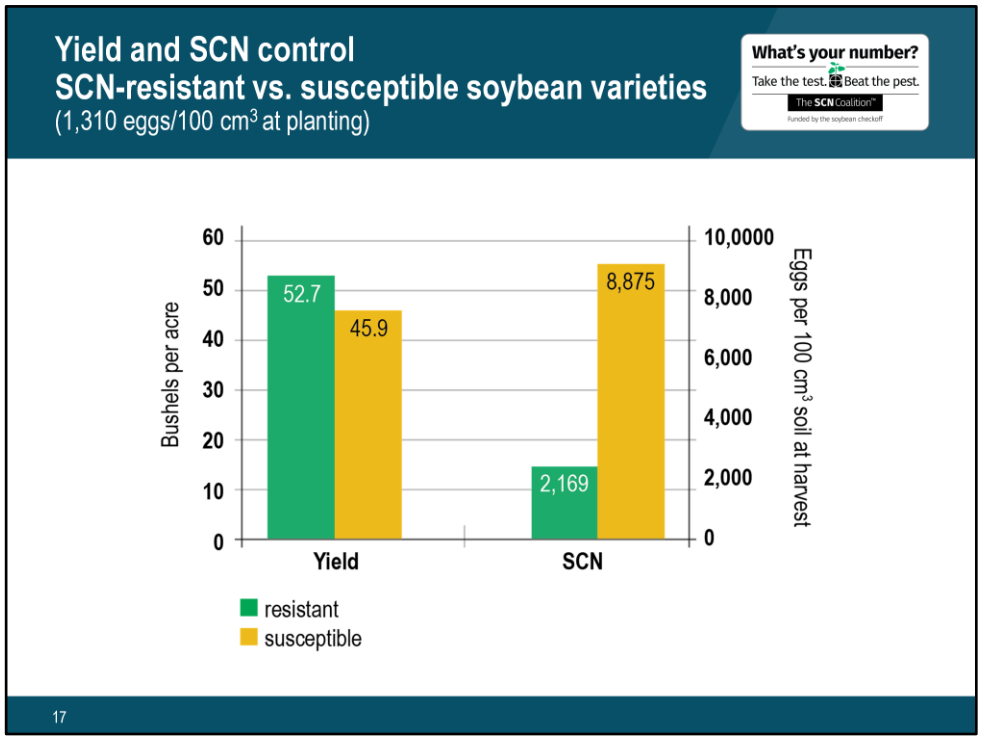
- Numbers of SCN eggs will decline in a year that a nonhost crop is grown because juveniles from some of the SCN eggs will hatch, then starve in the absence of soybeans or some other host crop.
- The greatest decrease in SCN numbers has been observed in the first year of a nonhost crop, with less of a decrease when a nonhost crop (like corn) is grown for a second, successive year.
- Lessening decreases in SCN numbers in successive years of corn is believed to be because eventually only dormant SCN eggs will be left in the soil.
- Dormant SCN eggs can live 10 years or more without hatching.



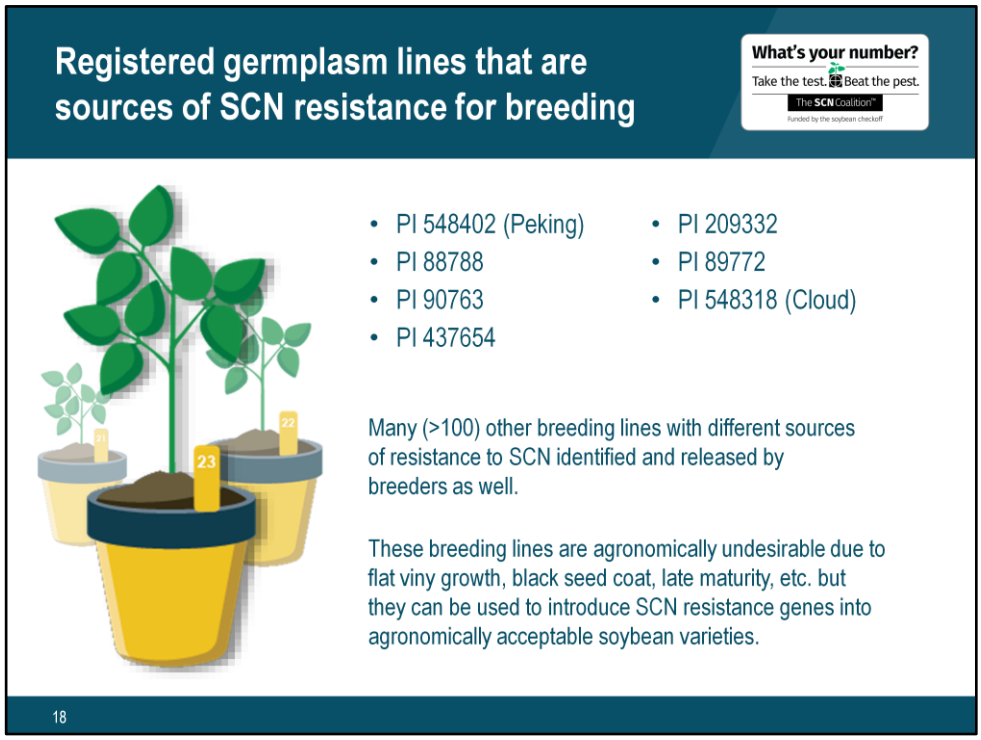
It's literally almost black & white. Or in this photo, dark green versus pale green. You see a **susceptible variety** on the left, and a resistant variety on the right.

The bargain of the century here is that the seed of a resistant variety doesn't cost any more than the seed of a susceptible variety – it's **free**.

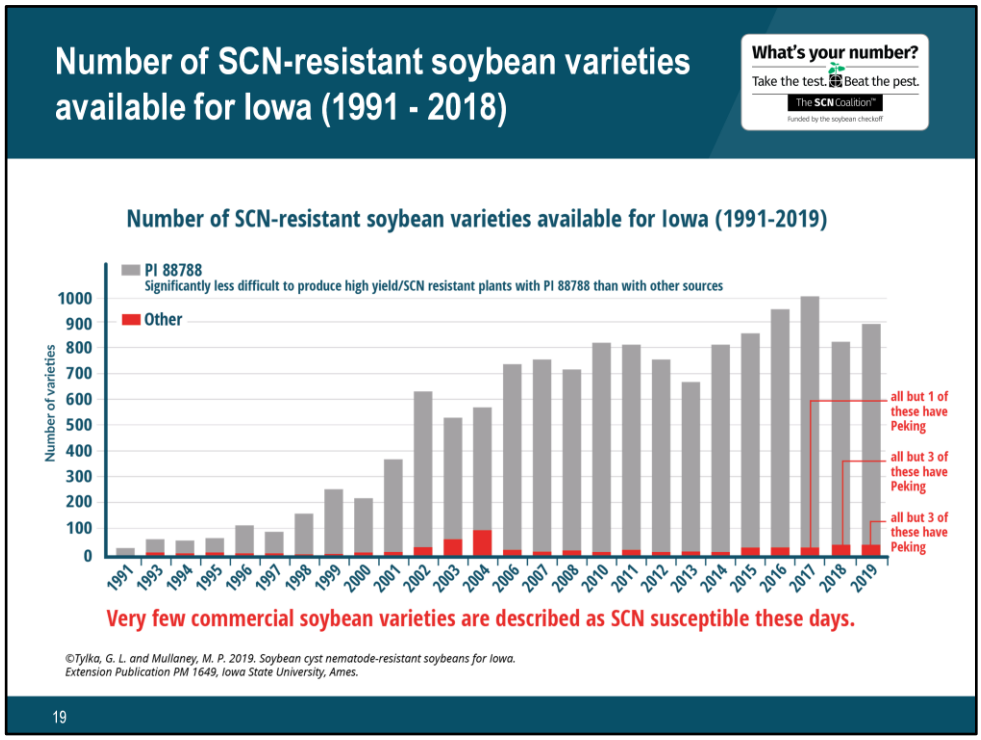
This has been a wonderful thing: the free protection we get from SCN-resistant soybeans. But it may turn out to be a fatal flaw.



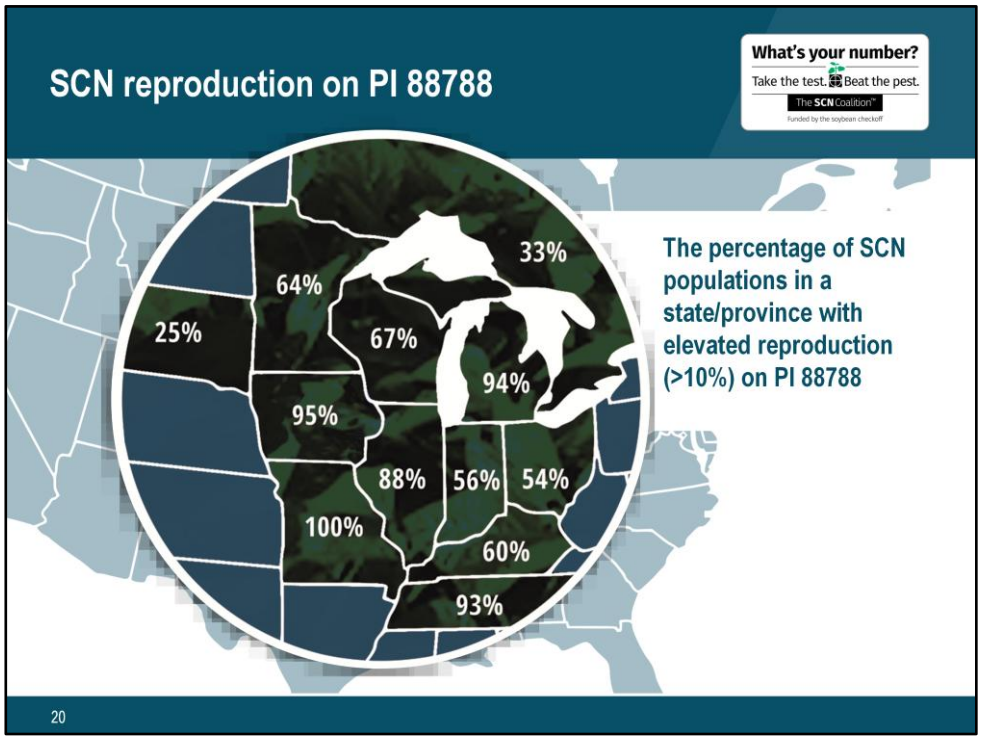
- Typical yield and SCN control results for susceptible versus SCN-resistant soybean varieties (multiple varieties of each type combined). The data are mean yields and mean end-of-season SCN numbers for a variety evaluation experiment in eastern Iowa.
- The starting egg number in the field was 1,310 eggs per 100 cc of soil (considered a "low" egg count.)
- Yields of resistant varieties were, on average, 6.8 bushels more than yields of the susceptible varieties.
- The end-of-season SCN numbers in the soil under the resistant soybean varieties were, on average, 1/4th of the of the number under the susceptible varieties.



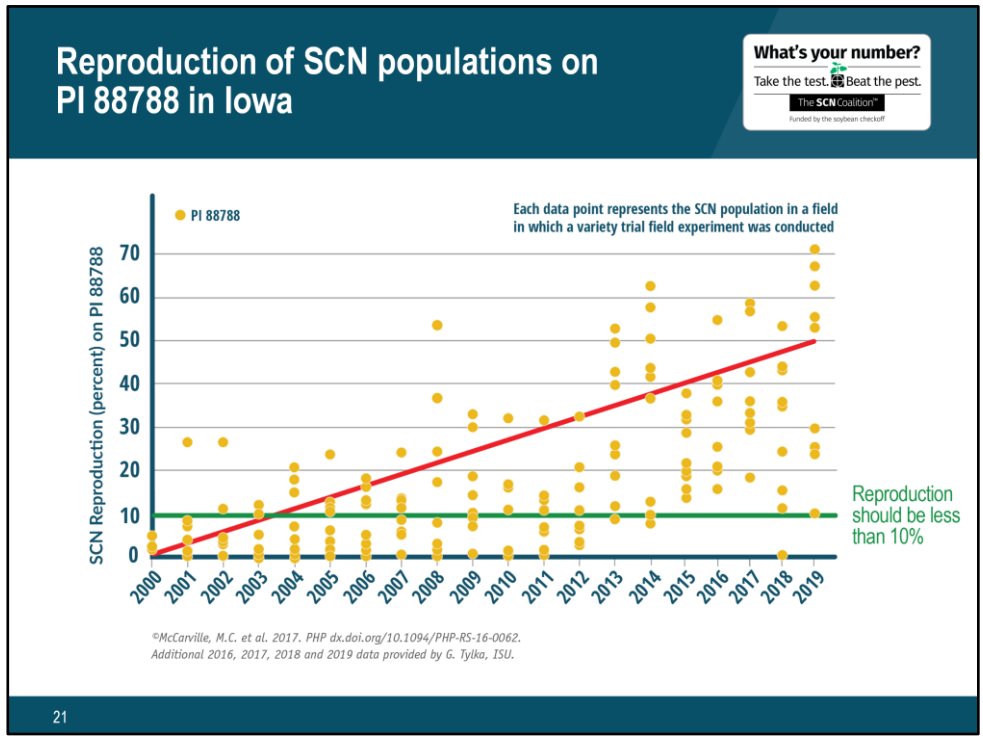
- There are many soybean breeding or germplasm lines, referred to as "sources of resistance," that can be used to breed SCN-resistant soybean varieties.
- The seven germplasm lines listed in the bullets here have been officially "registered" by being published in a scientific journal. ("PI" stands for "Plant Introduction" – a plant breeding term)
- Many other germplasm lines also have been reported by scientists to be resistant to SCN.
- These soybean lines could not be grown as a crop themselves, but are used by soybean breeders to make crosses with good agronomic soybean varieties in hopes of making those varieties SCN resistant.



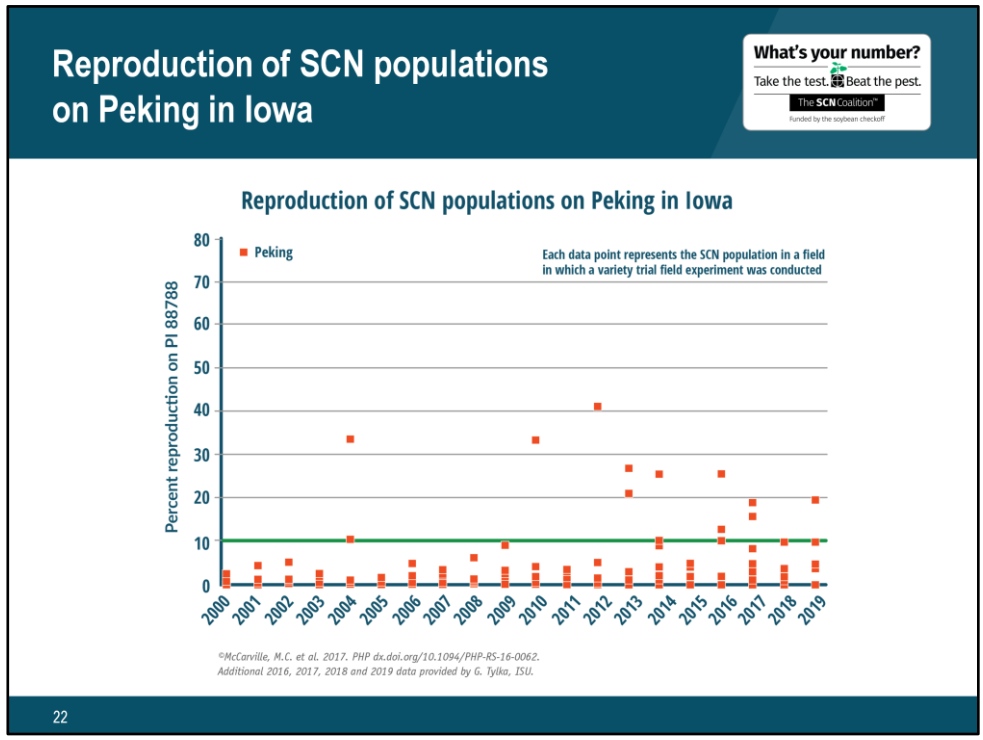
- This graph shows the number of SCN-resistant soybean varieties in maturity groups 0, 1, 2, and 3 available for use in Iowa from 1991 through 2018. Data are not available for 1992, 2005, and 2009.
- The gray portion of each bar is the number of varieties with SCN resistance genes from PI 88788, the red portion is the number of varieties with a source of resistance other than PI 88788.
- The reason for the overwhelming use of PI 88788 for breeding SCN resistance is it is significantly less difficult to produce high yielding AND SCN-resistant plants with PI 88788 than with the other sources of resistance.
- In 2017, there were 1,002 named SCN-resistant soybean varieties for Iowa farmers, and all but 29 had PI 88788 SCN resistance. All but 1 of the 29 varieties with resistance other than PI 88788 had Peking SCN resistance.
- In 2018, there were 820 total resistant varieties, 38 of which don't have PI 88788 resistance. And all but 3 of those 38 have Peking resistance.
- In 2019, there were 891 total resistant varieties, 41 don't have PI 88788 resistance, and all but 3 of the 41 have Peking resistance.



- This map shows the results of surveys conducted in numerous states and in Ontario, Canada, to assess the level of reproduction (percent) of SCN populations on pure PI 88788.
- The percentages on the map reflect how common it was in the surveyed fields to encounter an SCN population with elevated (>10%) reproduction on PI 88788.

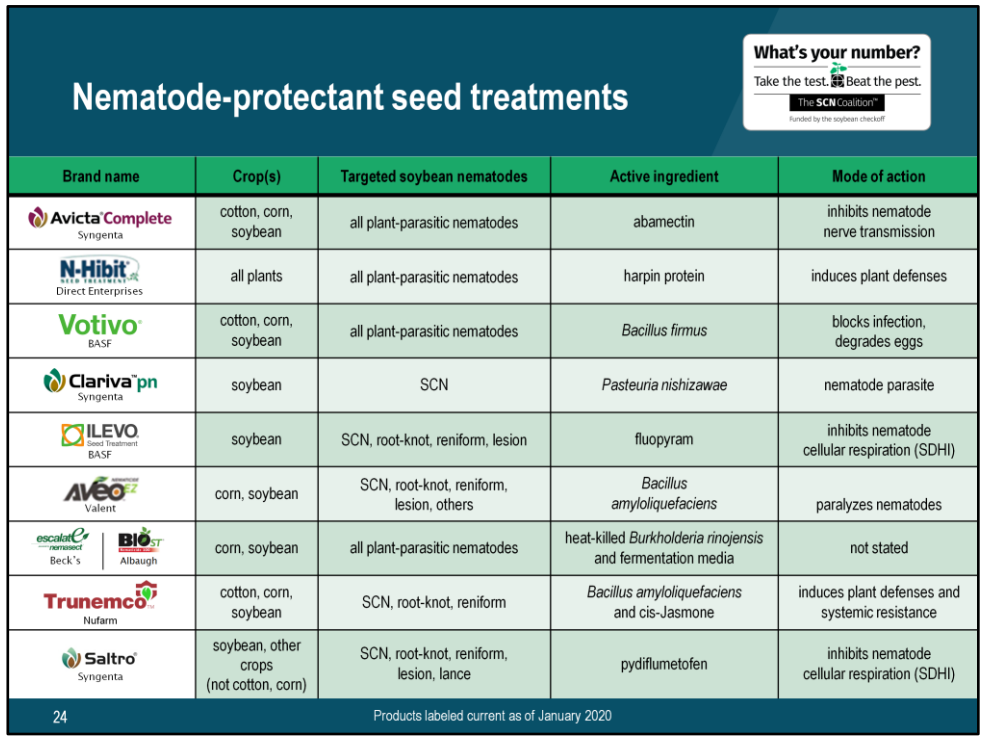


- The level of reproduction (percent) on pure PI 88788 of SCN populations in Iowa farm fields in which field experiments were conducted to evaluate the performance of SCN-resistant soybean varieties from 2000 through 2017.
- Effective SCN control should keep nematode reproduction below 10%.
- Levels of reproduction on PI 88788 were below 10% for SCN populations in Iowa farm fields in which resistant variety evaluation experiments were conducted from 1991 through 1999 (those years are not represented on the graph).
- Levels of reproduction on PI 88788 for SCN populations in Iowa farm fields began increasing in 2001 and are usually well above 10% now.



- Increased levels of reproduction (>10%) on Peking for SCN populations in Iowa farm fields has not been consistently detected.

- It is not likely that many new varieties with non-PI 88788 resistance will become available in the near future because there is possibly no revenue to be gained by companies to develop varieties with other sources of SCN resistance (because there is no price premium for seed of SCN-resistant varieties).
- Most every soybean variety and breeding line used in commercial soybean breeding programs today has PI 88788 in its background.



Nematode-protectant seed treatments

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Brand name	Crop(s)	Targeted soybean nematodes	Active ingredient	Mode of action
Avicta Complete Syngenta	cotton, corn, soybean	all plant-parasitic nematodes	abamectin	inhibits nematode nerve transmission
N-Hibit Direct Enterprises	all plants	all plant-parasitic nematodes	harpin protein	induces plant defenses
Votivo BASF	cotton, corn, soybean	all plant-parasitic nematodes	*Bacillus firmus*	blocks infection, degrades eggs
Clariva pn Syngenta	soybean	SCN	*Pasteuria nishizawae*	nematode parasite
ILEVO Seed Treatment BASF	soybean	SCN, root-knot, reniform, lesion	fluopyram	inhibits nematode cellular respiration (SDHI)
AVEO EZ Valent	corn, soybean	SCN, root-knot, reniform, lesion, others	*Bacillus amyloliquefaciens*	paralyzes nematodes
escalate nemasect Beck's / BIOST Albaugh	corn, soybean	all plant-parasitic nematodes	heat-killed *Burkholderia rinojensis* and fermentation media	not stated
Trunemco Nufarm	cotton, corn, soybean	SCN, root-knot, reniform	*Bacillus amyloliquefaciens* and cis-Jasmone	induces plant defenses and systemic resistance
Saltro Syngenta	soybean, other crops (not cotton, corn)	SCN, root-knot, reniform, lesion, lance	pydiflumetofen	inhibits nematode cellular respiration (SDHI)

24 Products labeled current as of January 2020

- Currently available nematode-protectant seed treatments approved for use in the U.S. – not all are available in Canada.

Nematode-protectant seed treatments

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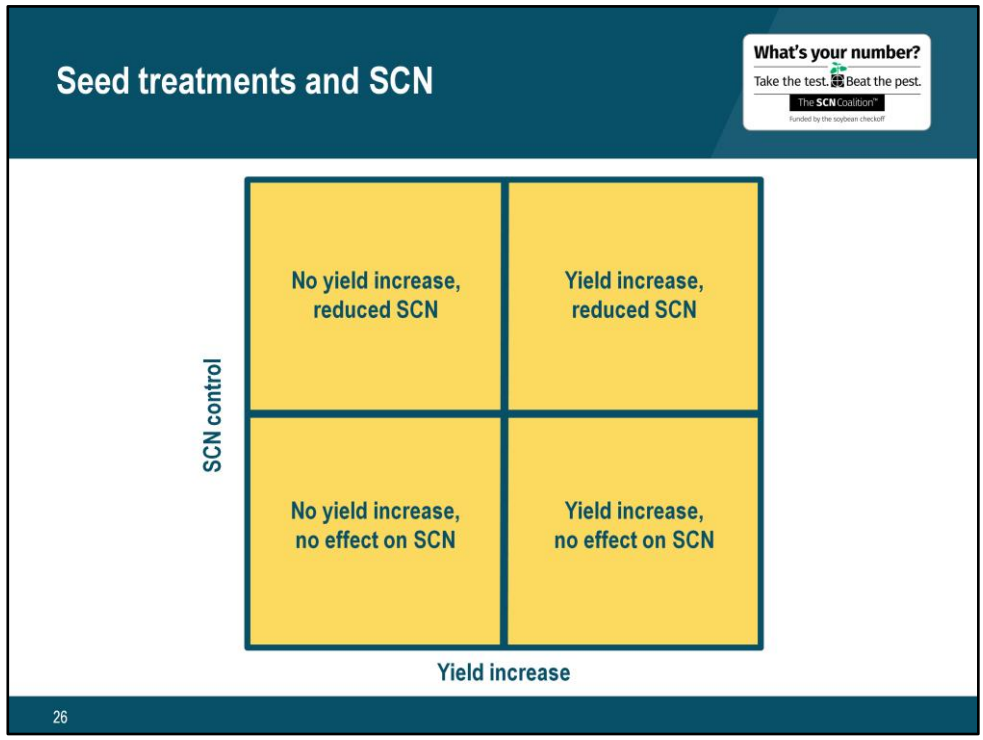
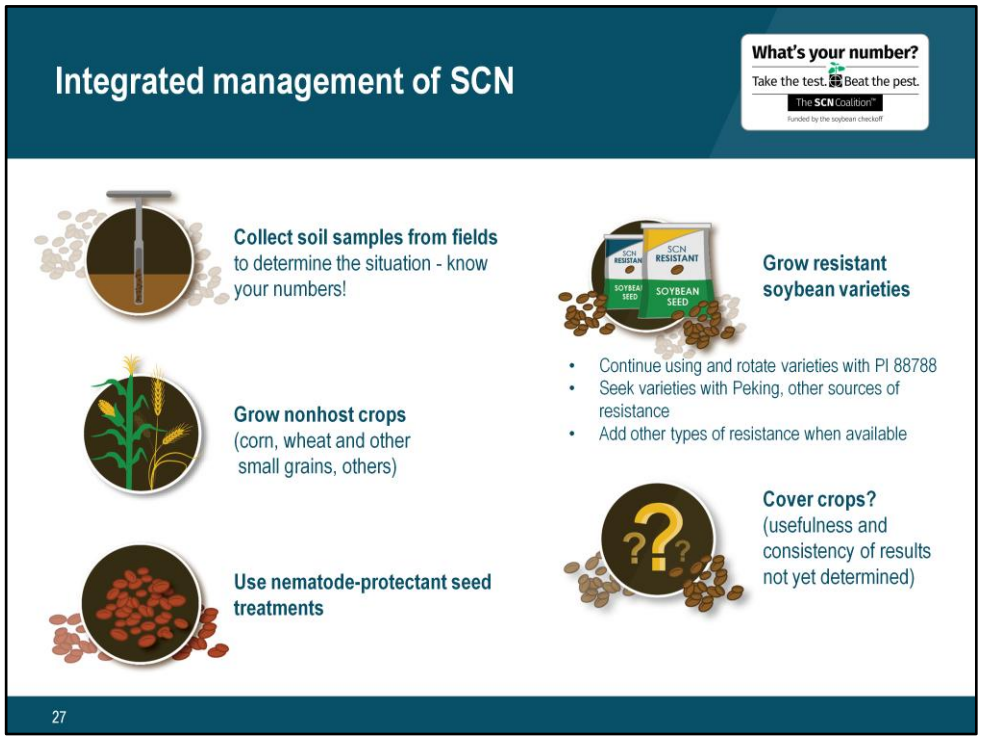
- **Effective seed treatments** should slow the continuing loss of effectiveness of PI 88788 SCN resistance
- **Yield and SCN** effects may be different for new seed treatment products with new modes of action



- The nematode-protectant seed treatments may reduce SCN reproduction, may increase soybean yields in SCN-infested fields, may have both effects, or may have no effect.
- Results will vary among the different seed treatment products, among growing seasons, and maybe among soil environments, too.



- Summary of SCN management options for 2020 and beyond.
- Cover cops show some promise for reducing SCN population densities, but actual effects (backed up with published data) seem to be much, much less dramatic and less consistent than the SCN-control claims being made by some purveyors of cover crop seeds.