Where do we stand with soybean cyst nematode, resistance, and seed treatments?

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The soybean cyst nematode (SCN), *Heterodera glycines*, is a major yield-limiting factor of soybean in the United States and Canada (table 1). One thing contributing to the large amount of damage caused by SCN is its widespread distribution. The nematode has been found in every soybean-producing state in the United States except West Virginia and in all Iowa counties (figure 1) (Tylka and Marett 2017). And results of repeated random surveys of Iowa done in the 1990s (Workneh et al. 1999) and in the mid 2000s and in 2017 (Tylka unpublished) indicate SCN is present in 60% to 70% or more of the fields in Iowa.

Table 1. Five most destructive soybean diseases and most recent estimated annual yield losses in the northern United States (IL, IN, IA, KS, MI, MN, NE, ND, OH, PA, SD, WI) and Ontario, Canada, from 2011 to 2014. Yield loss values are expressed in thousands of bushels. (Source: Allen et al. 2017)

	2011		2012		2013		2014	
Rank	**Disease**	**Loss**	**Disease**	**Loss**	**Disease**	**Loss**	**Disease**	**Loss**
1	SCN	90,525	SCN	118,697	SCN	112,394	SCN	108,008
2	Seedling diseases	46,847	Charcoal rot	59,481	Seedling diseases	43,672	Seedling diseases	60,305
3	Phyto-phthora	33,180	Phyto-phthora	23,950	Charcoal rot	31,865	SDS	46,815
4	Charcoal rot	29,403	Seedling diseases	23,642	Phyto-phthora	29,134	white mold	40,709
5	SDS	22,835	SDS	21,831	SDS	20,391	Phyto-phthora	32,864

SCN = soybean cyst nematode; SDS = sudden death syndrome; Phytophthora = Phytophthora root and stem rot; Seedling diseases = diseases caused by *Fusarium*, *Phomopsis*, *Pythium*, and/or *Rhizoctonia* species; white mold = Sclerotinia stem rot.

Managing with resistant soybean varieties

Resistant soybean varieties have been a very effective and economical means of managing SCN for several decades. The resistant varieties allow relatively low SCN reproduction and produce profitable yields compared to susceptible varieties (Tylka et al. 2016). And the cost of seed of resistant soybean varieties is no more than seed of susceptible (non-resistant) varieties. Unfortunately, a great majority (97%) of the SCN-resistant soybean varieties available for Iowa have contained resistance genes from a single breeding line or source of resistance, called PI 88788 (McCarville et al. 2017, Tylka and Mullaney 2017). A similar situation exists with SCN-resistant varieties in many other states in the north central United States.

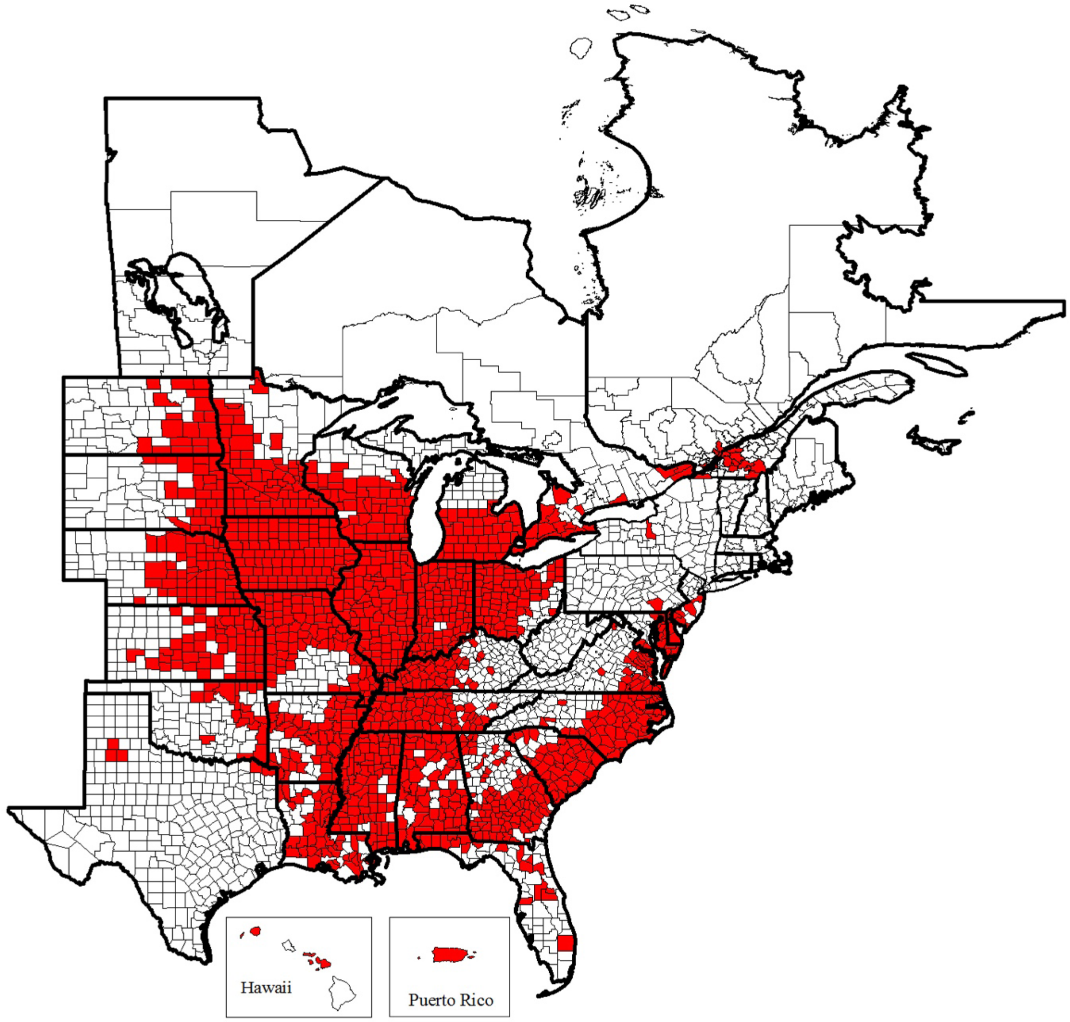

Figure 1. Known distribution of the soybean cyst nematode in the United States and Canada as of 2017 (Source: Tylka and Marett. 2017)

Growing soybean varieties with the same SCN resistance genes year after year is akin to using a single pesticide active ingredient on populations of insects, fungi, or weeds year after year. Eventually, the pest population can build up resistance to the pesticide or resistance genes. And such is the case with SCN populations in Iowa and PI 88788 SCN resistance genes.

Throughout the 1990s, resistant varieties with the PI 88788 source of resistance were effective, holding Iowa SCN populations to less than 10% reproduction. But beginning in the early 2000s, reproduction of Iowa SCN populations began increasing on varieties with PI 88788 resistance, and levels of 50% or greater reproduction now are not uncommon (McCarville et al. 2017).

Farmers are advised to grow soybean varieties with different sources of resistance and also to grow different soybean varieties with the common PI 88788 source of resistance to delay the build-up of resistance-breaking populations of SCN. Farmers also should have fields sampled to determine and monitor the levels or population densities of SCN present in the soil.

Managing with nematode-protectant seed treatments

Nematode-protectant seed treatments are a relatively new management option for SCN. The first products that became available, in the 2000s, were Avicta, N-Hibit, and Votivo. Several more products were released in subsequent years, and currently there are seven choices (table 2), with more new products likely to come in future years.

Table 2. Characteristics of currently available nematode-protectant seed treatments. (Source: Bissonnette and Tylka 2017)

Product name, company	Crop(s)	Targeted nematodes	Active ingredient	Mode of action
Avicta Complete from Syngenta	cotton, corn, soybean	all ppns	abamectin	inhibits nerve transmission
N-HIBIT from Plant Health Care, Inc.	all	all ppns	harpin protein	bolsters natural plant defenses
VOTiVO from Bayer CropScience	cotton, corn, soybean	all ppns	*Bacillus firmus*	repels nematodes from roots
Clariva pn from Syngenta	soybean	SCN	*Pasteuria nishizawae*	nematode parasite
ILeVO from Bayer CropScience	soybean	SCN, RKN, reniform, lesion	fluopyram	SDHI enzyme inhibitor
NEMASTRIKE from Monsanto	cotton, corn, soybean	SCN, RKN, reniform, lesion	tioxazafen	mitochondrial translation inhibitor
AVEO Nematicide from Valent	corn, soybean	SCN, reniform, lesion	*Bacillus amylo-liquefaciens*	under investigation

ppns = plant-parasitic nematodes; SCN = soybean cyst nematode; RKN = root-knot nematode; reniform = reniform nematode; lesion = root-lesion nematode.

An interesting aspect of nematode-protectant seed treatments is that each product has a different active ingredient and mode of action. Some products have chemicals and others have biological organisms as active ingredients. Many, but not all, of the seed treatments have direct effects on SCN. Some products are very specific for SCN, such as Clariva, whereas some have activity against several species of plant-parasitic nematodes. Most of the nematode-protectant seed treatments are not sold as stand-alone products, rather are offered bundled on top of seed insecticides and fungicides.

Use of nematode-protectant seed treatments may reduce SCN reproduction, may increase soybean yields, may have both effects, or may have no effect (figure 2). The results obtained when using these seed treatments undoubtedly will vary among the different products and likely also will vary among growing seasons and, perhaps, among soil environments and other yet-to-be-identified factors.

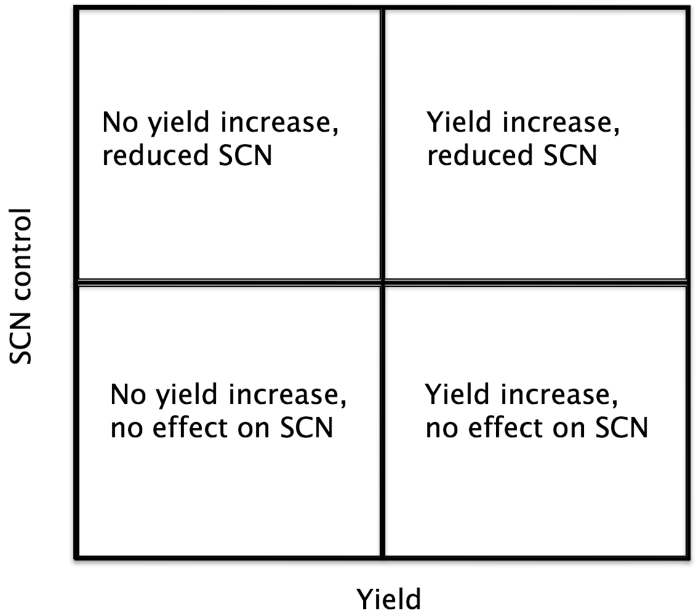

Figure 2. Possible effects of nematode-protectant seed treatments on soybean yields and SCN population densities. Results will vary among seed treatment products and possibly across environments and soil conditions.

Conclusion

Because of the high reproductive abilities of SCN on soybeans and its very effective long-term survival in the soil in the absence of host plants, successful long-term management requires coordinated use of all available management tactics, which include growing nonhost crops, growing resistant soybean varieties, and using nematode-protectant seed treatments.

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