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USING HG TYPE TO SELECT SCN-RESISTANT SOYBEAN VARIETIES

Heterodera glycines, the soybean cyst nematode (SCN), has been and continues to be a major yield-limiting pest of soybean. Results from the latest survey of disease and nematode pests in the Midsouth states show it to be a significant contributor to pest-related soybean yield losses in each of the last six years.

Choosing soybean varieties with genetic resistance (or host plant resistance) to SCN has long been a major economical defense against this pest, and breeders/geneticists have continued to thwart the negative effects of SCN by releasing new soybean varieties with resistance to evolving types of this pest. The long-term effectiveness of genetic resistance to SCN is documented in a paper (Rincker et al., Crop Sci., Jan. 2017) entitled "Impact of Soybean Cyst Nematode Resistance on Soybean Yield". This presentation uses results from 11 years of yield tests that were conducted over 1,247 test-environment combinations in the north-central US and Canada.

Populations of SCN in soybean fields exhibit diversity in their ability to develop on resistant soybean varieties, and this variation has implications for management strategies that can be used to mitigate SCN damage. Since 1970, this diversity has been characterized by assigning a race designation to an SCN population in a given field. According to Dr. Terry Niblack et al. (J. of Nematology, Dec. 2002, "A revised classification scheme for genetically diverse populations of *H. glycines*"), an HG Type test better describes how a field population of *H. glycines* will affect a soybean variety that is planted in a given field that is infested with SCN. The authors further state that the HG Type test 1) can serve as a mechanism for classifying differences among field populations of nematodes or population changes over time, 2) can be used by nematologists and breeders to develop resistant soybean varieties and to describe nematode populations used for screening, and 3) can be used to develop management recommendations for producers.

The HG Type test uses seven indicator lines that have been used as sources of resistance for developing SCN-resistant soybean varieties, and a susceptible check. They are:

- PI 548402 (Peking) HG Type 1
- PI 88788 HG Type 2
- PI 90763 HG Type 3
- PI 437654 HG Type 4
- PI 209332 HG Type 5
- PI 89772 HG Type 6
- PI 548316 (Cloud) HG Type 7
- Lee 74 used as standard susceptible genotype.

In this test, the variable Female Index (FI = [mean number of SCN females on a soybean line being tested divided by mean number of females on the standard susceptible] x 100) is the value used to assign HG Type to a field population of SCN. A cutoff number of 10 (10%) was chosen for FI because it is assumed that populations with FI's less than 10 would not maintain themselves in the confines of a single growing season.

Results from an HG Type test must show the FI value along with the HG Type designation to avoid the inference that all populations with the same HG Type are equivalent.

According to Dr. Heather Kelly of the Univ. of Tennessee (utcrops.com Nov. 2018), "The scientific definition of a resistant variety (there is no legal definition in the US) is that a resistant variety should allow less than 10% reproduction relative to a susceptible variety (in other words, there should be 90% suppression or control). So the tool we have to test if an SCN population can reproduce more than 10% (relative to a susceptible variety) on any of the 7 main sources of resistance is called the HG Type test." The HG Type test replaces or should replace the SCN race test for determining or predicting SCN reproduction potential on resistant soybean varieties.

In a properly conducted HG Type test, a replicated set of indicator lines (those shown above) and the standard susceptible, Lee 74, are infested with equal numbers of *H. glycine* eggs taken from a field population of the nematode. After 30 days, the females that have developed on soybean roots are extracted from the soil, counted, and used to calculate an FI. Any indicator line with an FI ≥ 10 is considered a suitable host for the tested SCN population.

The result from the HG Type test is simply a list of the numbers from the above list of indicator lines that correspond to being suitable hosts. For example, HG Type 1.2.6 means that PI 548402 (Peking–HG Type 1), PI 88788 (HG Type 2), and PI 89772 (HG Type 6) had FI's ≥ 10 and therefore are considered suitable hosts for SCN development. An HG Type 0 means that the nematode sample did not produce an FI ≥ 10 on any of the indicator lines.

The above-cited article provides great detail for conducting the HG Type test, including sampling protocol, source of seed for the indicator lines and susceptible variety, proper mixing of the field nematode sample, experimental design and growing conditions, and data collection.

The bottom line from HG Type test results follows.

If any of the seven indicator lines shown above produce an FI ≥ 10 from the nematode sample, then varieties with that source of resistance against SCN should not be used in the sampled field. Conversely, if the nematode population produces an FI < 10 on all the indicator lines, then any variety can be planted in the sampled field without regard for SCN resistance. It is important to remember that the HG Type designations resulting from the test are population descriptions and not genotypes of individual nematodes; i.e., the HG Type designation describes the SCN population in a field and not any one SCN individual, and indicates the relative ability of the overall SCN population in the field (represented by the sample) to reproduce on the HG indicator soybean lines.

Drs. Greg Tylka and Terry Niblack provide an example (Tylka and Niblack, NCSRP) of how the HG Type Test is used to determine the SCN population in a field.

Lee 74 (susceptible check)	250 females; **10% = 25**
Peking (indicator line 1)	17 females; **17/250 = 7 FI**
PI 88788 (indicator line 2)	73 females; **73/250 = 29 FI**
PI 90763 (indicator line 3)	3 females; **3/250 = 1 FI**
PI 437654 (indicator line 4)	19 females; **19/250 = 8 FI**
PI 209332 (indicator line 5)	9 females; **9/250 = 4 FI**
PI 89772 (indicator line 5)	16 females; **16/250 = 6 FI**

Cloud (indicator line 7)	28 females; **28/250 = 11 FI**

In the above example, the number of females on the roots of PI 88788 (FI = 29) and Cloud (FI = 11) exceed 10% of the number of females on Lee 74. Thus, the nematode population in this field is classified as HG Type 2.7 and the producer should consider growing an SCN-resistant variety that obtained its resistance from a source other than PI 88788 or Cloud. Note that the number of females on PI 88788 and Cloud are quite different. This confirms the importance of showing the FI value along with the HG Type designation to avoid the inference that all populations with the same HG Type are equivalent. Also, another SCN population could have twice the number of females on the same two indicator lines shown above (i.e., 146 and 56), but would still be classified as HG Type 2.7. However, the virulence of the population would be much greater on both indicator lines in the latter case.

Click here (Tylka, Plant Health Progress, June 2016) and here (Tylka, Iowa State Univ., Nov. 2006) for Dr. Tylka's publications that provide additional information on using the HG Type test to develop, implement, and monitor an SCN management plan using SCN-resistant varieties.

The HG Type test for SCN populations has become increasingly important because almost all SCN-resistant soybean varieties have SCN resistance genes from PI 88788. According to Dr. Niblack (Plant Health Progress, Jan. 2008), a significant portion of SCN populations in Illinois have adapted to PI 88788 to some degree, which in effect reduces the effectiveness of SCN-resistant varieties with this source of resistance. It is likely that this adaptation of SCN to PI 88788-derived resistance has/is occurring in other US soybean producing areas that have relied on this source of resistance for the development of SCN-resistant varieties.

Thus, the HG Type test is made to order to determine if SCN-resistant varieties that have been grown for an extended period in the same field have resulted in the selection of the SCN population in that field against the resistance acquired from PI 88788. This is why merely changing varieties for a given field that is infested with SCN will be ineffective if these different varieties all have SCN resistance acquired from the same source. This could explain why soybean growers may be seeing declining performance from SCN-resistant varieties in SCN-infested fields.

Dr. Niblack proposes short- and long-term solutions to this problem where it exists. In the short term, use varieties with resistance acquired from sources other than PI 88788. For the long term, rotate varieties with different SCN-resistance sources in order to slow SCN's adaptation to resistance and preserve the effectiveness of SCN-resistance sources.

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