Evaluation of Soybean Varieties and Breeding Lines for Resistance to Soybean Cyst Nematode and Their Copy Number Variation at *Rhg1* Locus

EXECUTIVE SUMMARY

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a. Importance of the Research
Soybean cyst nematode (SCN) causes a significant yield loss in soybean. Effective SCN management relies on resistant soybean varieties. However, overuse of limited resistance sources has led to the emergence of more virulent SCN populations. Evaluating breeding lines and commercial varieties for SCN resistance helps in selecting resistant soybeans. Most SCN-resistant varieties have PI 88788-type resistance, particularly involving genes at the *Rhg1* locus. Copy number variations (CNVs) at *Rhg1* determine the level of resistance to SCN. Therefore, screening of soybean lines and varieties and analyzing CNVs are important.

b. Research Conducted
This research aimed to evaluate soybean varieties and breeding lines for resistance responses to two common SCN populations in ND and to assess copy number variations (CNVs) at the *Rhg1* locus. A total of 152 soybean breeding lines and commercial varieties have been tested against HG type 2.5.7 (higher ability to reproduce on PI 88788), and HG type 0/7 (less to no ability to reproduce on PI 88788). Each line was inoculated with 2,000 SCN eggs, and grown under controlled growth chamber conditions (Fig. 1). After 32 days, white females were extracted and counted. Then female index was calculated, and resistance response was classified. CNVs at the *Rhg1* locus were detected using an optimized and validated qPCR assay.

c. Research Findings
Among 35 commercial soybean varieties, nine were found resistant to HG type 0/7, while six varieties were resistant to HG type 2.5.7. Five varieties showed resistance to both HG types. Among 117 breeding lines tested, six were resistant to HG type 7, while none of the lines was resistant to HG type 2.5.7. Twenty-five breeding lines were moderately resistant or resistant to both HG types. *Rhg1* copy numbers ranged from 1 to 11, with higher copies generally linked to greater resistance (Fig. 2). There was a strong negative correlation between the female indexes and copy numbers for both the populations.

d. Benefits
We identified soybean varieties and breeding lines with resistance to SCN from this research. Five of the commercial varieties tested were resistant to both HG types, offering valuable options for farmers to select resistant varieties to reduce yield losses. Additionally, 25 of the breeding

lines were resistant or moderately resistant to both HG types, providing a pool for developing new SCN-resistant varieties. Determining *Rhg1* copy number helps in the rapid selection of soybean lines with increased SCN resistance.

Fig 1. Soybean plants were tested for SCN resistance in a controlled growth chamber maintained at 27°C, ensuring optimal testing conditions.
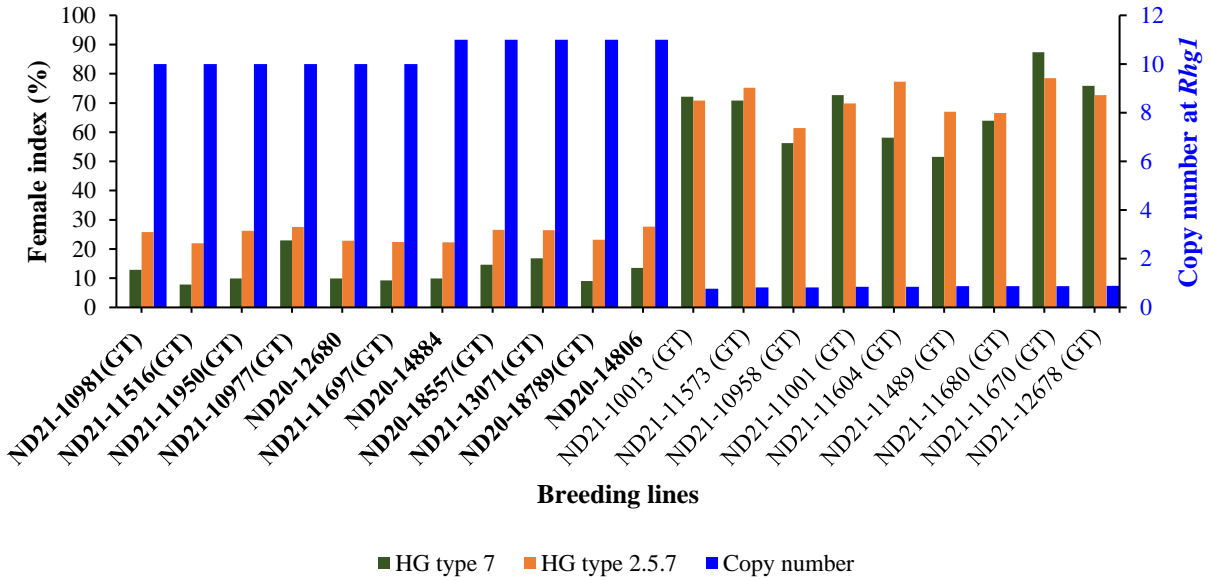
Fig. 2. Relationship between female indexes (%) and copy numbers at *Rhg1* locus of 20 selected breeding lines including 11 resistant or moderately resistant lines (bold) to both SCN populations and 9 susceptible or moderately susceptible lines to both populations. The primary y-axis represents the female index, while the secondary y-axis represents the copy number at the *Rhg1* locus.