

**Genetic Study on Resistance to Soybean Cyst Nematode (*Heterodera glycines*) Race 14 in Huibuzhi Black Bean from Xing County in Shanxi Province**

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## Introduction

*Heterodera glycines* is a serious disease in world soybean (*Glycine max*) production. Huibuzhi black bean from Xing county in Shanxi province, China is one of the most important sources of resistance. It is resistant to all investigated races, 1, 3, 4, 5 and 14 of SCN. It is also widely used in Chinese breeding programs as a resistant donor. The objective of this research is to determine SCN race type at the Experiment station, Plant Protection Institute, Chinese Academy of Agricultural Sciences in Beijing and to investigate the inheritance of resistance of the identified SCN race in

Huibuzhi black bean.

## Materials and methods

**Materials:** All race host differentials: Peking[GRIN], Pickett[GRIN], PI 88788[GRIN], PI 90763[GRIN] and Lee 68[GRIN] were obtained from Chen Senyu, Southern experiment station, University of Minnesota, USA. Seeds of the resistant cultivar, Huibuzhi black bean were provided by Li Ying, Shanxi Academy of Agricultural Sciences. Gidou 7 is a cultivar from Hebei province. Soil samples were taken from the Experiment station, Plant Protection Institute, and Chinese Academy of Agricultural Sciences in Beijing.

**Methods:** Five plants of each of the host differentials were evaluated for their reaction to the soil isolate from the Station to determine race type. A cross, Gidou 7 X Huibuzhi was made in the summer of 1995 in a net house at the Crop Germplasm Resources Institute, Chinese Academy of Agricultural Sciences, Beijing. F1 plants were randomly selected and self-pollinated to set F2 seeds in 1996. F2 seeds in different F1 plants were harvested respectively. Ten plants of each parent, 2 random F1 samples obtained in 1995 and 2 F2 families (including 116 plants in family 1 and 78 plants in family 2) obtained in 1996 were evaluated in the greenhouse for their reactions to the soil isolate. Randomly selected F2 seeds were planted and harvested in 1997 to obtain F3 families. Eighteen F2:3 families were randomly selected (10-15 seeds of each) and were evaluated for SCN resistance.

Seeds were germinated at 20°C with a 12h day-length in a culture container. Seedlings with a 3-4 cm long radical were transplanted into transparent column pots (20 x 7 cm) filled with steamed-pasteurized fine sandy soil (including 30% nutrient soil, 10% fine sandy soil and 60% loamy). Each seedling was inoculated with about 4,000 eggs and larvae during transplanting. Lee 68, a susceptible standard to all races and a sensitive parent, Gidou 7 were included in every inoculation. Inoculated seedlings were maintained in the greenhouse at 20°C with 12h daylength. About 40 days after inoculation, roots were examined for the presence of females. Investigations were conducted when females of SCN were maturing. The plastic column pot was carefully cut with a scalpel, and soil around the roots was gently taken away using needles, then the seedling with the entire radical was taken out from the soil. Plant roots were washed in a beaker with

water to rinse out the remaining soil on the roots. Numbers of white females present were counted. Soil left in the broken plastic pot was washed through 30 and 60-mesh sieves, water in the beaker was also poured through them. Residual on 60-mesh sieves were collected and filtered through 35 and 60-mesh sieves again. Cysts in the soil were counted. Finally, total cyst number of each plant was calculated.

Race category was based on the classification system of Riggs and Schmitt (1987). Female Index (FI) was calculated as (mean number of white females on each host differential / mean number of white females on Lee 68) x 100. SCN populations that had an FI of 10 or more on Peking, Pickett and PI 90763 but less than 10 on PI 88788 were called race 14, while race 4 reproduced on all four differentials as female indices of 10 or more. The index of parasitism (IP) was used to determine the reaction of each plant based on the system proposed by Golden et al (1970) which is calculated as (number of white females of a given individual / mean number of cysts on susceptible parent) x 100. Individuals that had IP of 10 or more were categorized as being susceptible. Chi-square ( $\chi^2$ ) analysis was performed to test the goodness of fit to hypothesized genetic ratio.

## Results and discussion

Race determination: Reactions of all differentials to SCN isolate from the Experiment station, Plant Protection Institute, Chinese Academy of Agricultural Sciences, Beijing is provided in Table 1. Female indices in this SCN population were 10 or more on Peking, Pickett and P190763 but less than 10 on PI 88788. According to the race classification system of Riggs and Schmitt, Race 14 was prevalent in the population.

Reactions to race 14 of parents, F1 and F2 families in the cross Gidou 7 x Huibuzhi: The reaction to race 14 of the parents, F1 and R vs. S frequencies for F2 plants are given in Table 2. Gidou 7 is sensitive and Huibuzhi black bean is resistant. The F2 populations in both random families fit a ratio of 43R:21S, the expected trihybrid ratio with one recessive gene and two dominant genes for resistance indicated by rRR in the table, presumably, one recessive epistatic gene pair and two dominant complementary gene pairs. If the recessive epistatic gene is homozygous, the other two gene pairs do not play their roles and the recessive gene resists the virulence of race 14. However, if it is dominant homozygous or heterozygous, the other

two dominant gene pairs show their effects to race 14. If these two genes are recessive homozygous or one dominant (homozygous or heterozygous) and the other is recessive homozygous the plant can not resist invasion of SCN 14, the reaction to race 14 is susceptible. Only if both of them are dominant (homozygous or heterozygous) is the reaction to SCN 14 is resistant. So these two genes are dominant complementation for the resistance to SCN race 14.

The hypothesized resistant genes were verified through F3 examination (Table 3). There were a total of 18 F2:3 families, with 242 individual plants used to screen for resistance to race 14. Five out of 18 families were categorized as resistant, 11 were segregating and 2 were susceptible. The segregation data fits the 19R:38Seg:7S ratio ( $X^2=0.038$ ,  $p > 0.95$ ). Therefore resistance to race 14 of soybean cyst nematode in Huibuzhi black bean was controlled by three genes, one recessive epistatic gene pair and two dominant complementary gene pairs.

## References

- Anand, S.C., and G.G. Myers. 1992. Genetic relationships between PI 437654 and other sources of resistance to soybean cyst nematode races 3, 5 and 14. *Soybean Gen. Newsl.* 19:149-155. [AGRICOLA]
- Golden, A.M., J.M. Epps, et al. 1970. Terminology and identity of intraspecific forms of the soybean cyst nematode (*Heterodera glycines*). *Plant Dis. Rep.* 54:544-546.
- Rao Arelli, A.P. 1994. Inheritance of resistance to *Heterodera glycines* race 3 in soybean accessions. *Plant Dis.* 78:898-900. [AGRICOLA]
- Riggs, R.D., and D.P. Schmitt. 1988. Complete characterization of the race scheme for *Heterodera glycines*. *J.Nematol.* 20:392-395. [AGRICOLA]