

Studies on the Soybean Cyst Nematode (*Heterodera glycines*) in China

Wei Zhi Liu, Ye Liu, Yu Xi Duan¹
Quan Chun Hong and Ke Ning Wang²

ABSTRACT Soybean has been cultivated in China for 5,000 years. The soybean cyst nematode (SCN), *Heterodera glycines*, was recognized in Northeastern China in 1899. Currently, it is known to occur in 12 provinces. The biology of SCN was investigated in several provinces. Six races of SCN were identified (race 1, 2, 3, 4, 5 and 7). About 10,000 soybean germplasm lines were evaluated for their resistance to race 1, 3, 4, and 5 of SCN. At least two black-seeded cultivars are resistant to all four races. Several tolerant soybean cultivars with yellow seed coat were released and are in production. Additional resistant cultivars are being developed. Nematicides were not applied in production. Potential biocontrol agents and related aspects are being investigated.

KEY WORDS Soybean, cyst nematode, *Heterodera glycines*

About 5,000 years ago, it was said, soybean had been domesticated and planted by farmers in China. The word "Soy" could be originally from the Chinese word pronounced "SOU", but now pronounced "SHU". Subsequently, soybean was introduced into other Asian countries and continents. No one knows, however, when soybean cyst nematode (SCN) was first discovered in China. According to some notes and reports, this nematode was investigated for the first time by A. L. Jaczevski *et al.*, Russian workers in Northeastern China in 1899 (Tai *et al.* 1958). There is the possibility that evolution could be parallel in the soybean cyst nematode with soybean. In the 1930's the nematode only occurred in a few places; but in the 1940's, it was spread over Northeast China (Liu *et al.* 1987), now it is present in Heilongjiang, Jilin, Liaoning, Neimenggu, Beijing, Hebei, Henan, Shandong, Shanxi, Anhui, Jiangshu and Shaanxi provinces (Chen & Li 1981, Wang 1981, Li *et al.* 1986, Zhang 1986, Gu 1988, Liu 1990, Liu *et al.* 1987, Liu & Li 1989, Liu & Liu 1989). In other provinces, there were no reports of its occurrence likely because of the lack of extensive sampling.

Many years ago, Chinese farmers know that the rotation of soybean with grain crops could control the soybean cyst nematode. In the 1940's, a local soybean cultivar "Pingdingxiang" was selected to be resistant to the nematode (Liu *et al.* 1987). At present, breeders are developing new resistant soybean cultivars.

INVESTIGATION OF THE RACES OF SOYBEAN CYST NEMATODE

The biology of SCN was investigated in detail in various conditions of several provinces (Liu & Shang 1981, Wang 1984, Yang 1984, Liu *et al.* 1985, Yang *et al.* 1987, Liu 1990, Liu & Zhou 1990, Liu *et al.* 1993). The nematode can reproduce at 3~4 generations in a growing season in Northeastern China and 5 or 6 generations in Beijing in the (spring) soybean area, and 4 generations in the (summer) soybean area (Chen & Li 1981, Zhou *et al.* 1984, Liu *et al.* 1985, Zhang 1986).

Investigation of the races of SCN in China was begun in Shenyang Agricultural University, by using the methods and the host differentials described by

Shenyang Agricultural University, Shenyang, 110161, China

¹Professor, Associate Professor, and Lecture, respectively, Department of Plant Protection, Shenyang Agricultural University

²Graduate Students, Shenyang Agricultural University

Table 1. Distribution of the races of soybean cyst nematode in China

Races	Provinces of distribution
1	Liaoning, Jilin, Shandong
2	Shandong
3	Liaoning, Jilin, Heilongjiang, Neimenggu
4	Shandong, Shanxi, Hebei, Henan, Beijing, Anhui, Jiangsu
5	Anhui
7	Shandong

A.M. Golden *et al.*, W.Z. Liu *et al.* (Liu *et al.* 1984) reported that two races of SCN were identified for the first time in Northeast China in 1984. They are race 1 and 3, race 1 occurred in Liaoning Province and Jilin Province, and race 3 in east Liaoning, Jilin, Heilongjiang, and Neimenggu Provinces. Since then, race 2 was found in Shandong Province, race 4 in the Yellow River Valley (Li *et al.* 1987, Liu & Liu 1989, Shang & Liu 1989, Xing 1989), race 5 in Anhui (Zhang 1986), and race 7 in Shandong Province (Chen *et al.* 1987) (Table 1). Identification of the races of SCN has promoted the screening of resistant sources and breeding new soybean cultivars (Liu 1986, Li *et al.* 1987, Liu *et al.* 1987, Ma *et al.* 1989, Liu *et al.* 1991, Chang *et al.* 1993).

SELECTION AND VARIATION OF THE RACES OF SOYBEAN CYST NEMATODE ON RESISTANT SOYBEAN VARIETIES

Liu *et al.* (1993, 1994a,b) reported that populations of race 1 and 3 of SCN were selected on 9 soybean lines: Peking, Xiao Li black soybean, Xiao Li Hei, Harbin, Chang Li Hei, Tie Feng 18, Franklin, Fayette and Lee. The first 6 soybean varieties are recognized as Chinese resistant germplasm. The seedlings were transplanted into the noninfected soil after the nematode penetrated into the soybean roots. In the noninfested soil, surviving nematodes were then inbred 10~12 generations on the original host lines. The variations of the races were identified with the standard differentials of SCN for each population. The results showed that after the selection, the original population of race 1 became the

race 4, 5, 6 and 9 on the Peking, Franklin, Xiao Li, Tie Feng 18 and Fayette, respectively, and that the population of race 3 became race 2, 4, 13 and 14 on Harbin, Tie Feng 18, Chang Li Hei, Franklin and Peking, respectively. The populations reproduced on Lee was still race 3. According to these experiments, the race status of SCN populations should change in response to selection pressure for 10~12 generations on the single resistant variety.

SCREENING OF RESISTANT SOURCES

Several province had been screening resistant sources to SCN before the recognition of the races of SCN, and found some resistant germplasm with black seed coat collected from farmers (Wu *et al.* 1982, Wu *et al.* 1984, Zhang *et al.* 1985). In 1985, Liu & Liu (1985) reported nine soybean cultivars with black seed coat to be resistant to race 3 of SCN. In 1987, Liu *et al.* (1988) present four soybean cultivars resistant to race 1 and 3 in Liaoning. In 1987, Li *et al.* (1987) reported 11 soybeans resistant to race 4 in Shanxi Province. From 1986~1990, about 10,000 soybean germplasm lines were evaluated for their resistance to race 1, 3, 4 and 5 of SCN by a national cooperative group in six locations. Finally, two black-seeded soybean cultivars (Wuzhai black soybean and Huipizhi black soybean) were found to be resistant to all four races of SCN. More than 100 cultivars are resistant to race 1, 3, 4 or 5 of SCN, respectively (Liu 1986, Li *et al.* 1987, Liu *et al.* 1987, Liu & Liu 1989, Chang *et al.* 1993). Up to now, all the resistant germplasm lines are black seeded.

BREEDING FOR RESISTANCE

Chinese farmers were always selecting soybeans they liked. In the 1940's agronomists invested extensive efforts in looking for resistant soybeans with yellow seed coats from 1,000 cultivars collected from farmers in Northeast China. One of them, the cultivar "Pingdingxiang" was considered to be the best (Liu *et al.* 1987). By the 1970's, nematologists began to select tolerant yellow soybeans from local cultivars and lines. Among them, Bainong No. 2

was found to be tolerant by the Baicheng Agricultural Institute in Jilin Province (Zhou & Xu 1984), and Nenfung No. 52 was also selected by Nenjiang Agricultural Institute in Heilongjiang Province (Gu 1986, Li *et al.* 1986). These two cultivars were released in production. In 1970's, Wu *et al.* (1989) began to breed new resistant cultivars by crossing the yellow-seeded ones with the black-seeded "Harbin" in Heilongjiang Province. They selected 3 lines called "resistant materials". By 1980's, after introduction of resistant soybeans from the USA, the breeding for resistance was intended to use resistant soybeans from abroad as resistant sources on the Fuyu Seed Farm (Heilongjiang Province) and Shenyang Agricultural University. New resistant lines were forthcoming (Liu 1986). Recently, a new yellow line resistant to race 5 was selected in Anhui Province (Zhang 1986).

NATURE AND INHERITANCE OF RESISTANCE

The nature for resistance to SCN in soybeans was investigated only recently. Development of cyst nematode in roots of soybean cultivars was observed histologically after roots were infested with the race 1 of SCN by Liu *et al.* (1988) in Shenyang Agricultural University in 1988. They found that development of the nematode was very fast in roots on the susceptible soybeans, and syncytia were observed. With the resistant cultivars Peking and Moushi black soybean, however, the development of the nematode was very slow, and host cells surrounding the lip of the nematode were necrotic. They suggested that this (hypersensitive reaction) may be a resistant mechanism. In 1994, Hong *et al.*, reported that there were no relation in SCN juveniles quantitative trends with resistance of soybeans. Syncytia were initiated whether in resistant or susceptible cultivars when SCN 2-stage juveniles penetrated in soybean roots, but development was terminated early and necrosis associated with syncytia disintegrate in resistant cultivars. 4-stage juvenile numbers in the roots were closely related to the response of resistance in soybeans (Hong *et al.* 1994).

Recently, inheritance of resistance in soybeans to

SCN was studied. H. Xing (Xing 1989) investigated inheritance of several resistant soybeans against race 1 of SCN in Shandong Province. There were three recessive genes in three soybean lines and two recessive genes with one dominant genes in a resistant soybean cultivar controlling resistance to race 1 of SCN (Xing 1989). Wang *et al.* (1990) researched inheritance of soybeans resistant to race 4 of SCN in Shanxi Province. They found that there were two recessive genes in their resistant soybeans controlling their resistance to race 4 of SCN on the background of their susceptible cultivars. Liu *et al.* (1994) studied inheritance of resistance of Chinese black-seeded soybeans to SCN race 3 in Shenyang. They found that resistance of Xiao Li black soybean was conditioned by one dominant and one recessive gene to Tie Feng 24 cultivar, four dominant genes to Kai Yu 10 cultivar. Resistance of Moshi black soybean was controlled by two recessive genes to Tie Feng 24. In moderately resistant parent cross combination, Lian Mao Hui black soybean X Tie Feng 18, indicated that there were complementary effect of three loci. Liu *et al.* (1994) reported that applying procedures of Interorganismal Genetics, resistant genes of Chinese black-seeded soybeans were postulated and grouped with Peking, PI88788 and PI90763 that had known resistant genes, Chang Li black soybean carried the same genes with Peking, Harbin soybean carried the same genes with PI90763, Xiao Li black soybean had more genes for resistance to race 14 than PI90763, and Moshi black soybean had less genes for resistance to race 14 than PI88788. Lian Mao Hui black soybean should only carry genes for resistance to race 3.

RELATIONSHIP TO NON-HOST PLANTS

The ranges of host plants of SCN were studied in some regions during the past decade (Chen & Li 1981, Liu *et al.* 1987, Liu 1990). Most host plants were in the Leguminosae. C.T. Chen *et al.* (Chen & Li 1981) found that SCN can parasitize the roots of *Rehmannia*, a medical plant. They observed that juveniles of SCN can penetrate the roots of some non-host plants, but cannot develop into adults. Yang *et al.* (1984) reported that the secre-

tions of roots in some non-host plants, such as corn, sorghum, and cotton, appear likely to inhibit hatching of egg of SCN. Liu & Liu (1990) reported that castor bean (*Ricinus communis*) is not a host of SCN, but its root secretions can stimulate hatching of eggs of SCN. The juveniles also died without a host, and the density of SCN had decreased by the next year. Several nematologists had investigated the population dynamics of SCN in a field under rotation systems. Rotation with non-host plants is always a good measure of control (Liu *et al.* 1983, Zhou 1984, Liu *et al.* 1985, Liu *et al.* 1987, Liu & Zhou 1990).

BIOLOGICAL CONTROL

Many workers have evaluated applications of nematicides to control these nematodes, and suggested several chemicals for practical use (Wang & Liu 1981, Liu *et al.* 1985, Li *et al.* 1986, Zhang 1986, Zhou & Xu 1984, Liu *et al.* 1987, Gu 1988, Liu & Li 1989). Still, farmers were never interested in using them because of the great expense. Recently, some fungi were isolated from diseased cysts of SCN in a few locations. Liu (1990) collected more than 100 isolates of fungi from the eggs of SCN from Shandong and Jiangsu provinces. *Fusarium* spp. were the predominant species, and others were *Cylindrocarpon destructans*, *Cuvrularia* sp. and *Neocosmospora vasinfecta* var. *vasinfecta*. Liu *et al.* (1987, 1994) isolated the fungi *Cylindrocarpon* spp., *Glomus* spp., *Fusarium solani*, *Paecilomyces lilacinus*, *Phoma* spp., *Stagnospora heteroderae* and *Verticillium chlamydosporium* from the cysts of SCN in Heilongjiang, Jilin, Henan and Shanxi provinces. Liu, W.Z. *et al.*, isolated 25 species of fungi from the cysts of eggs of SCN collected from Northern China (Liu, W.Z. *et al.*, unpublished). They are: *Acromonium kiliense*, *Botryotrichum piluliferum*, *Chaetomium perlucidum*, *C. elatum*, *Cladosporium cladosporioides*, *Cunninghamella elegans* Lendner, *C. echinulata* (Thaxt.) Thaxt., *Cylindrocarpon destructans*, *Fusarium aquaeductum*, *F. equiseti*, *F. oxysporum*, *F. solani*, *Humicola fuscoatra*, *Mariannaea elegans*, *Mucor petrisularis*, *Paecilomyces lilacinus* (Thom.) Savaon, *P. variotii* Bainer, *Paraphoma ra-*

dicina, *Scytalydium indonesiacum*, *Trichoderma* sp., *Verticillium coccosporum*, *V. nigrescens*, *V. lecanii*, *V. chlamydosporium* Goddard var. *chlamydosporium* Gams, *Volutella ciliata*, and are being reinoculated onto the cysts in Shenyang Agricultural University to determine their efficiency in controlling the nematode in the field. This endeavor should be exciting during the next few years.

PROSPECTS

Soybean has been planted in various agro-ecological systems of China for 5,000 years. Soybean germplasm is rich in China. However, the races of SCN are complex and variable and the parasites of the nematode are very diverse. The main land of China may be a large pool of soybean germplasm, parasitic genes of the nematode and parasites of the nematode.

Chinese farmers can control the nematode for prolonged periods by rotating soybean cultivars and rotating soybean with non-host plants, and by spreading manure favorable to the growth of soybean plants and microorganisms which can parasitize the nematodes in the soil. Scientists are studying all the experiences and practices and are helping farmers to integrate management tactics into a balanced system. The breeders are screening more resistant sources and developing new resistant cultivars. The nematologists will continue to identify new races of SCN, to detect more parasites of the nematode, and to implement more effective control measure to meet the challenge of the future.

REFEREMCES

- Chang, R.Z., W.Z. Liu (and Coordinative group of evaluation of SCN). 1993. Evaluation of soybean germplasm for resistance to race 1, 3, and 4 of the soybean cyst nematode. *Soybean Science* 12(2): 91-99.
- Chen, C.T. & Z. Li. 1981. On the infestation of *Rehmannia* by the soybean cyst nematode. *Acta Phytopathologica Sinica* 11: 37-55.
- Chen, P.S., D.S. Zhang & S.Y. Chen. 1987. First report on a new physiological race (race 7) of the soybean cyst nematode (*Heterodera glycines*). *Scientia Agricultura Sinica* 29(2): 94.

- Gu, C.Y. 1988. Occurrence of pests in soybean and control. *Heilongjiang Agricultural Science* 3: 32-34.
- Hong, Q.C., W.Z. Liu, Y. Liu & Y.X. Duan. 1994. Studies on resistance characters of Chinese black seeded soybeans to soybean cyst nematode. *Liaoning Agricultural Science* 3: 15-16.
- Li, G.Z., Y.Z. Lei, Z.Y. Yang & S.Y. Wang. 1986. Progress in research on the soybean cyst nematode. *Heilongjiang Agricultural Science* 1: 19-22.
- Li, Y., Z. Wang & B.G. Wei. 1987. The screening and utilization of new resistant sources to the soybean cyst nematode race No. 4. *Soybean Science* 6(4): 291-297.
- Liu, M.S. 1990. Isolations of fungi parasitizing soybean cyst nematode in Eastern China. *Chinese Journal of Biological Control* 6(1): 38-41.
- Liu, S., Z.X. Deng, Q. Wu, Q.H. Zhou, H.Y. Zao & C.J. Wang. 1985. The study on the soybean cyst nematode. *Henan Agricultural Science and Technology* 6: 12-15.
- Liu, H.Q. & S.G. Shang. 1981. Study on generations of soybean cyst nematode in Heilongjiang Province. *Heilongjiang Agricultural Science* 5: 44-47.
- Liu, H.Q., S.G. Shang, H. Huo, H.L. Wu, Z.C. Yao & X.L. Li. 1985. A preliminary report on the study of the soybean cyst nematode (*Heterodera glycines*). *Soybean Science* 4(2): 131-135.
- Liu, H.Q., S.G. Shang, H. Huo, H.L. Wu, Z.C. Yao & X.L. Li. 1987. Present status of occurrence, injury, and research of the soybean cyst nematode in Heilongjiang Province. *Soybean Science* 6(2): 141-149.
- Liu, H.Q., S.G. Shang & H. Huo. 1987. Control of the soybean cyst nematode. *Heilongjiang Agricultural Science* 4: 41.
- Liu, H.Q., S.G. Shang & H. Huo. 1989. Resistance of soybean cultivars to race 1, 3, and 4 of the soybean cyst nematode. *Soybean Science* 8(1): 113-114.
- Liu, J. & Q.R. Li. 1989. Occurrence of soybean cyst nematode and chemical control. *Jiangsu Agricultural Science* 6: 24-26.
- Liu, T.R., S.Z. Wang & L.L. Li. 1983. Diseases of oil crops and their control. Shanghai Technique Press, p.18-44.
- Liu, W.Z., Y. Liu & P.S. Chen. 1984. A preliminary result of identification of soybean cyst nematode races in Northeastern China. *Journal of Shenyang Agricultural College* 2: 75-78.
- Liu, W.Z. & Y. Liu. 1985. Resistance test of Liaoning local soybean cultivars to race 3 of *Heterodera glycines*. *Scientia Agricultura Sinica* 4: 25-29.
- Liu, W.Z. 1986. A discussion for speeding up breeding soybean cultivars resistant to the soybean cyst nematode. *Soybean Science* 5(1): 77-82.
- Liu, Y., W.Z. Liu & T.J. Sun. 1987. Test of resistance of local soybean cultivars from Northeastern China to race 1 and 3 of the soybean cyst nematode. *Journal of Shenyang Agricultural University* 18(4): 41-44.
- Liu, Y. & W.Z. Liu. 1988. Development of the soybean cyst nematode within roots of soybean cultivars. *Liaoning Agricultural Science* 4: 16-18.
- Liu, Y. & W.Z. Liu. 1989. Identification of races of soybean cyst nematode (2nd report). *Journal of Shenyang Agricultural University*. 20(1): 41-44.
- Liu, Y. & W.Z. Liu. 1990. Effects of rotating castor bean and soybean on controlling *Heterodera glycines*. *Journal of Shenyang Agricultural University* 21(3): 236-238.
- Liu, Z.Z. & Y.Z. Zhou. 1990. Study on ecological distribution of soil microorganisms and colony dynamics of cyst forming nematodes in continuous and rotation cropping systems of soybean. *Soybean Science* 3: 206.
- Liu, X.Z., D.S. Zhang, X.Y. Wu, C.Y. Shen & W.F. Chiu. 1991. Preliminary studies on the parasites from the cyst of *Heterodera glycines*. *Acta Agriculturae Universitatis Pekinensis* 17(3): 87-91.
- Liu, W.Z., Y. Liu & Y.X. Duan. 1991. Test of soybean germplasms from Huang, Huai and Hai river valley for resistance to race 1 of soybean cyst nematode. *Soybean Science* 10: 327-329.
- Liu, W.Z., Y. Liu & Y.X. Duan. 1993. Selection effect of resistant soybeans on the race 3 of soybean cyst nematode, *Heterodera glycines*. *Acta Phytopythologica Sinica* 20(2): 135-137.
- Liu, W.Z., Q.C. Hong, Y. Liu & Y.X. Duan. 1993. Genetic analyses on the resistance of the Chinese black seeded soybeans to the race 3 of *Heterodera glycines*. Abstracts of 6th International Congress of Plant Pathology. (1993): Montreal, Canada. p202: 11, 1, 8.
- Liu, W.Z., Y. Liu & Y.X. Duan. 1993. Selection and variation of the races of *Heterodera glycines* on resistant soybean varieties. Abstracts of 6th International Congress of Plant Pathology. (1993), Montreal, Canada, p211. 11, 3, 15.
- Liu, W.Z., Y. Liu, Y.X. Duan & J.G. Baldwin. 1994a. Observation on morphology of soybean cyst nematode in China. *Journal of Shenyang Agricultural Un-*

- iversity **25**(2): 164-167.
- Liu, W.Z., Q.C. Hong, Y. Liu & Y.X. Duan. 1994b. Application of interorganismal genetics concept in grouping soybean genes resistant to soybean cyst nematode. *Soybean Science* **13**(1): 1-4.
- Liu, X.Z., R.J. & Z.L. Qin. 1994. Discovery of vesicular-arbuscular mycorrhizal fungi colonized in *Heterodera glycines* in China. *Acta Pedologica Sinica* **31**(supplement): 230-233.
- Ma, S.J., H.L. Wu, Y.H. Zhang, H.W. Liu, S.G. Shang, H. Huo, F.L. Wang & G.J. Gao. 1989. A preliminary report on resistance test of soybean germplasm from Huang, Huai and Hai river regions to race 3 of the soybean cyst nematode. *Soybean Science* **8**(2): 122.
- Shang, S.G. & H.W. Liu. 1989. Distribution of races of the soybean cyst nematode in three provinces in Northeastern China. *Soybean Science* **8**(4): 382.
- Tai, F.L., W.N. Xiang & R.Y. Zhang. 1958. The pathogen notes of economic plants in China. Academic Press (Beijing, China), p.147
- Wang, C. J. 1981. A preliminary study of the occurrence and control of the soybean nematode. *Liaoning Agricultural Science* **3**: 25-27
- Wang, H.T. & G.F. Liu. 1981. The results of chemical control of the soybean cyst nematode. *Heilongjiang Agricultural Science* **4**: 24-28.
- Wang, Z. & Y. Li. 1984. A preliminary investigation of the soybean cyst nematode. *Shanxi Agricultural Science* **4**: 26-27.
- Wang, Z. & Y. Li. 1990. Inheritance and translocation of resistance of soybeans to race 4 of the soybean cyst nematode. *Shanxi Agricultural Science* **6**: 4-6.
- Wu, H.L., Z.C. Yao, X.L. Li, H. Lin, H.Q. Liu, S.G. Shang & H. Huo. 1982. Studies on the screening of resistant sources to the cyst nematode of soybean. *Scientia Agricultura Sinica* **15**: 19-24.
- Wu, H.L., Z.C. Yao, X.L. Li, H.Q. Liu, S.G. Shang & D.Q. Mao. 1984. Studies on the methods of detections of resistance to cyst nematode (*Heterodera glycines*) Soybean Science **3**: 1-6.
- Wu, H.L., Z.C. Yao, X.L. Li, S.J. Ma & Z.F. Luo. 1989. Breeding of soybean new germplasm resources resistant to soybean cyst nematode (*Heterodera glycines* Ichinohe). *Soybean Science* **3**: 227-232.
- Xing, H. 1989. Identification of races of the soybean cyst nematode (*Heterodera glycines*) in Shandong Province and inheritance of soybeans to race 1 of the soybean cyst nematode. M.S. Thesis in Janjing Agricultural University. 1989.
- Yang, D.L. 1984. A study on the biology of the soybean cyst nematode. *Liaoning Agricultural Science* **5**: 23-26.
- Yang, R.Z., J.J. Chen & J. Zhang. 1987. Studies on the infection and physiological pathogenesis of hosts by the soybean cyst nematode. *Anhui Agricultural Science* **1**: 69-72.
- Zhang, L. 1986. The occurrence and control of the soybean cyst nematode in Anhui. *Anhui Agricultural Science* **2**: 54-58.
- Zhang, R.S., Y.Y. Niu, L.G. Bao & J.J. Gao. 1985. Identification and selection of soybean cultivars resistant to the soybean cyst nematode (*Heterodera glycines* Ichinohe). *Soybean Science* **4**(2): 137-140.
- Zhang, S.L. 1985. The investigation of the soybean cyst nematode in Shandong Province. *Shandong Agricultural Science* **2**: 42-43
- Zhang, Z. 1957. A preliminary report on investigation of diseases in soybean for export in Northeastern China. *The knowledge of Plant Diseases* **1**(2): 37-41.
- Zhou, G.F. & G.F. Xu. 1984. A study of control of the soybean cyst nematode. *Jilin Agricultural Science* **4**: 56-60.
- Zhou, S.Q., Z.R. Wang & F.Y. Ge. 1984. A study of the soybean cyst nematode generations on summer soybean in the north of Huai river. *Anhui Agricultural Science* **1**: 52-54.