First Report of *Heterodera filipjevi* on Winter Wheat from Hebei Province in North ChinaJiangkuan Cui,^{1,†} Haohao Ren,¹ Bo Zhou,¹ Kunyuan Chen,¹ Deliang Peng,² Minmin Li,³ Haoguang Meng,¹ and Shijun Jiang¹¹ College of Plant Protection, Henan Agricultural University, Zhengzhou, Henan 450002, China² Institute of Plant Protection, Chinese Academy of Agricultural Sciences, Beijing 100193, China³ Plant Protection Central Station of Shandong Province, Jinan, Shandong 250100, China

Funding: This research was supported by the National Natural Science Foundation of China (31801717), Science and Technology Planning Project of Henan Province of China (212102110443), and the Key Laboratory of Agricultural Environment and Agricultural Product Safety of Guangxi (AA17204043). Plant Dis. 105:1861, 2021; published online as <https://doi.org/10.1094/PDIS-11-20-2519-PDN>. Accepted for publication 22 January 2021.

Heterodera avenae, *H. filipjevi*, and *H. latipons* are the most economically important cyst nematodes that affect cultivated cereals around the world. *H. filipjevi* was first detected in China from Xuchang, Henan Province, in 2010 (Peng et al. 2010) and now has been recorded in Central China in Henan, Shandong, and Anhui provinces and in Northwest China in Xinjiang Uygur Autonomous Region (Cui et al. 2020). In June 2019, 42 samples (roots and soil) were collected from winter wheat fields in Hebei Province. Cysts were detected in 37 samples (mean, 6.4 ± 1.67 cysts/100 ml of soil). Cysts and second-stage juveniles (J2s) were extracted following Cobb's sieving gravity method. Morphological and molecular studies confirmed identity, with *H. filipjevi* in five samples from Handan (N36°10'052", E114°35'056"; N36°37'054", E114°22'052"), Xingtai (N36°53'060", E114°30'011"), and Shijiazhuang (N 37°26'048", E 116°05'039"). Morphologically, cysts are lemon-shaped, light or dark brown in color. The vulval cone is bifurcate with horseshoe-shaped semifenestrae, strongly globular bullae, and well-developed underbridge. Measurements, mean $\pm$ SD (range), of cysts ($n = 10$): body length not including neck, 743.0 ± 36.1 (665 to 780) μ m; body width, 559.0 ± 50.0 (455 to 639) μ m; length/width ratio, 1.33 ± 0.07 (1.20 to 1.46); neck length, 99.3 ± 8.8 (85 to 122) μ m; fenestrae length, 56.8 ± 5.0 (49 to 65) μ m, and width, 25.5 ± 1.8 (21.1 to 27.8) μ m; underbridge length, 84.0 ± 8.1 (62 to 93) μ m; vulval slit length, 8.6 ± 0.5 (7.2 to 9.1) μ m. Measurements of J2s ($n = 12$): body length, 541 ± 11.4 (490 to 578) μ m; stylet length, 22.3 ± 0.5 (22.0 to 25.0) μ m with anchor-shaped basal knobs; tail length, 57.7 ± 3.7 (52.7 to 65.2) μ m; hyaline tail terminal length, 36.5 ± 2.8 (32 to 39.8) μ m. The tail had a sharp terminus. Morphology was consistent with *H.*

filipjevi (Peng et al. 2010; Subbotin et al. 2010). Amplifications of rDNA-ITS fragments were generated with a PCR fragment of 1,054 bp from single cysts of each population, using primers TW81 and AB28 (Joyce et al. 1994). PCR tests for each sample were repeated five times. The PCR product was purified and sequenced. ITS-rDNA sequences were submitted to GenBank under MW282843 to MW282846. ITS sequences were >99.5% identical to *H. filipjevi* from Egypt (KF225725), Turkey (KR704308, KR704293, MN848333), and China (KT314234, MT254744, KY448473). Results were confirmed by species-specific sequence characterized amplified region primers of *H. filipjevi* (Peng et al. 2013). Pathogenicity was confirmed by infection of winter wheat (*Triticum aestivum* L. 'Aikang58') and examination of nematode development and reproduction. Wheat seeds were germinated in Petri dishes and then transplanted into five polyvinyl chloride tubes (3 cm diameter, 25 cm length) containing 150 cm³ of a sterile soil mixture (loamy soil/sand = 1:1), each with five cysts (mean, 252.0 eggs/cyst). Plants were grown in an artificial climate box for 1 week at 14/18°C, 2 weeks at 16/20°C, 5 weeks at 18/25°C, and 2 weeks at 22/30°C, under 8-h darkness/16-h light and normal culturing practices (Cui et al. 2015). The parasitic J2s, third- and fourth-stage juveniles, and adult females were observed in roots stained with acid fuchsin at 10, 20, 30, and 50 days after inoculation (DAI), and an average of 32.0 cysts/tube were extracted at 70 DAI. Morphological and molecular characteristics matched *H. filipjevi* cysts from the original samples. Three other tubes without cysts were a control, with no newly formed cysts. *H. avenae* and *H. filipjevi* had been detected in 16 wheat-producing provinces in China, with losses of 1.9 billion CNY/year (Cui et al. 2015). This is the first report of *H. filipjevi* in Hebei Province. Cereal cyst nematodes are easily transferred to noninfested areas, resulting in increased species and pathotype complexity (Cui et al. 2020). Once *H. filipjevi* spreads in the main wheat producing area, it could become a new threat to cereal production. Effective control methods are needed to prevent *H. filipjevi* dispersal, especially through farming machinery transmission. Hebei Province is a major grain-producing area. Our findings are beneficial for *H. filipjevi* management and further research on winter wheat in Hebei Province.

References:

- Cui, J. K., et al. 2015. J. Integr. Agric. 14:724.
 Cui, J. K., et al. 2020. Plant Dis. 104:3230.
 Joyce, S. A., et al. 1994. Page 178 in: Cost 812 Biotechnology: Genetics of Entomopathogenic Nematode-Bacterium Complexes. European Commission, Luxembourg.
 Peng, D. L., et al. 2010. Plant Dis. 94:1262.
 Peng, H., et al. 2013. Plant Dis. 97:1288.
 Subbotin, S. A., et al. 2010. Page 441 in: Systematics of Cyst Nematodes (Nematode: *Heteroderinae*). Vol. 8B. BRILL, Leiden, The Netherlands.

The author(s) declare no conflict of interest.

e-Xtra

Keywords: winter wheat, cereal cyst nematode, *Heterodera filipjevi*, Hebei Province, North China

[†]Indicates the corresponding author.
 J. K. Cui; jk_cui@163.com