RESEARCH NOTE

Stem Rot of Bonnet Bellflower Caused by *Rhizoctonia solani* AG-4

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ABSTRACT

In July and September 2020, a severe outbreak of stem rot was observed on bonnet bellflower (*Codonopsis lanceolata*) plants in a farm located in Chuncheon, Gangwon Province, Korea. The symptoms initially appeared on the stem at or above the soil line. Later, the infected stem completely rotted and blighted. The incidence of diseased plants in the field was 2–30%. Ten isolates of *Rhizoctonia* sp. were obtained from the stem lesions of diseased plants. All isolates were identified as *Rhizoctonia solani* AG-4 based on the morphological characteristics and anastomosis test. Three isolates of *R. solani* AG-4 were tested for pathogenicity on bonnet bellflower plants through artificial inoculation. All tested isolates induced stem rot symptoms on the inoculated plants. The symptoms were similar to those observed in plants from the farm. This is the first report of *R. solani* AG-4 causing stem rot in bonnet bellflower.

Keywords: Anastomosis, Bonnet bellflower, Pathogenicity, *Rhizoctonia solani* AG-4, Stem rot

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Bonnet bellflower (*Codonopsis lanceolata* (Siebold & Zucc.) Benth. & Hook.f. ex Trautv.) belongs to the family Campanulaceae and its native distribution ranges from East Russia to China, Korea, and Japan [1]. It is cultivated in Korea as a wild vegetable and medicinal plant. In July and September 2020, a severe outbreak of stem rot was observed in bonnet bellflower plants in a farm located in Chuncheon, Gangwon Province, Korea. The symptoms initially appeared on the stem at or above the soil line. The infected parts of the stem turned dark brown to black in color and rotted (Fig. 1A). With the progression of the disease, the infected stem completely rotted and blighted (Fig. 1B) and severely diseased plants died (Fig. 1C). Three sites in the field were designated to investigate the disease incidence and fifty plants from each site were investigated for the disease incidence. The incidence of diseased plants in the field was 2−30%.

The diseased stems of bonnet bellflower plants were collected and the fungal pathogen was isolated from the stem lesions. The 3–5 mm-long lesion pieces cut from the diseased stems were surface-sterilized with 1% sodium hypochlorite solution for 1 min and plated on 2% water agar. The fungal mycelia growing from the lesion pieces were transferred to potato dextrose agar (PDA) slants after incubating the plates at 25°C for one day. Ten isolates of *Rhizoctonia* sp. were obtained from the stem lesions (Table 1) and examined for their morphological characteristics using a compound microscope (Nikon Eclipse Ci-L, Japan). All isolates were identified as *Rhizoctonia solani* Kühn as per descriptions from previous studies [2, 3].

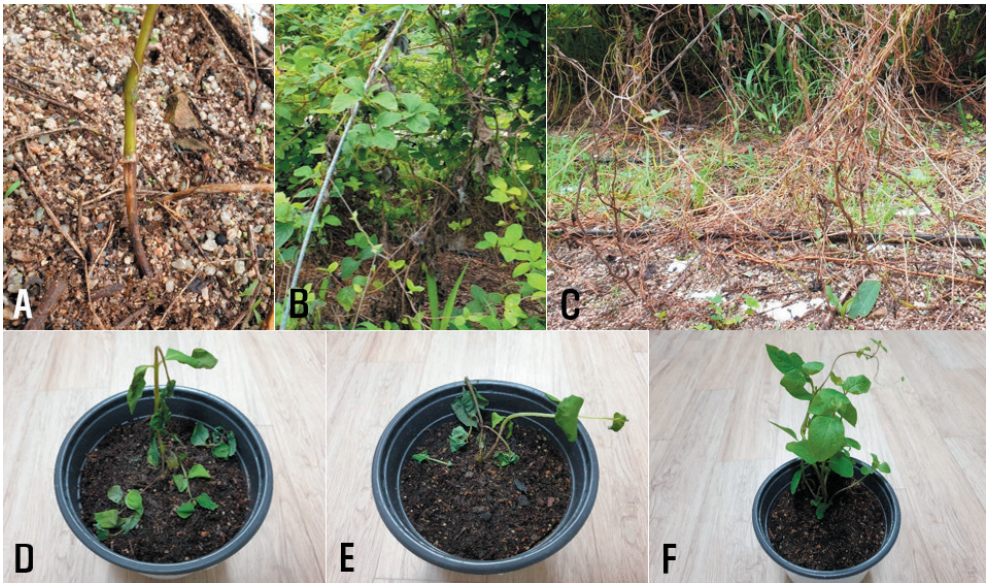

Fig. 1. Stem rot symptoms of bonnet bellflower plants. A–C: Symptoms observed in the field investigated. D and E: Symptoms induced by artificial inoculation tests with *Rhizoctonia solani* AG-4 isolates. F: A non-inoculated plant (control).

Table 1. List of *Rhizoctonia* sp. isolates from bonnet bellflower plants in a field in Chuncheon, Korea in July and September 2020.

Isolate No.	Plant part isolated	Date isolated
CLRS-2021	Stem	July 18
CLRS-2023	Stem	July 18
CLRS-2025	Stem	July 18
CLRS-2026	Stem	July 18
CLRS-2027	Stem	September 5
CLRS-2028	Stem	September 5
CLRS-2029	Stem	September 5
CLRS-2030	Stem	September 5
CLRS-2031	Stem	September 5
CLRS-2032	Stem	September 5

The *R. solani* isolates were tested for the identification of anastomosis groups using tester isolates of *R. solani* (AG-1 through AG-5) as previously described [4, 5]. All tested isolates were classified as *R. solani* AG-4. Anastomosis reactions between the tested isolate and the tester isolate of *R. solani* AG-4 are shown in Fig. 2A. The colony of the isolates cultured on PDA displayed whitish light brown in color (Fig. 2B). Sclerotia were absent or rarely formed on the medium.

Three isolates of *R. solani* AG-4 were tested for pathogenicity on bonnet bellflower plants via artificial inoculation. Mycelial disks of 6 mm in diameter cut from the margins of actively growing cultures of each isolate on PDA were placed on the stems at the soil surface level of 56-day-old bonnet bellflower plants grown in circular plastic pots (height: 13.5 cm; upper diameter: 15 cm; lower diameter: 10 cm) in a vinyl

greenhouse. Inoculated plant pots were placed in plastic boxes (71.0 cm × 53.5 cm × 40.5 cm) under 100% relative humidity at room temperature (24−26℃) for 2 days. Thereafter, the inoculated plant pots were taken out of the plastic boxes and kept indoors at room temperature. The pathogenicity of isolates was rated based on the degree of stem rot symptoms 5 days after inoculation. The inoculation test was conducted in triplicate, with one plant per replicate.

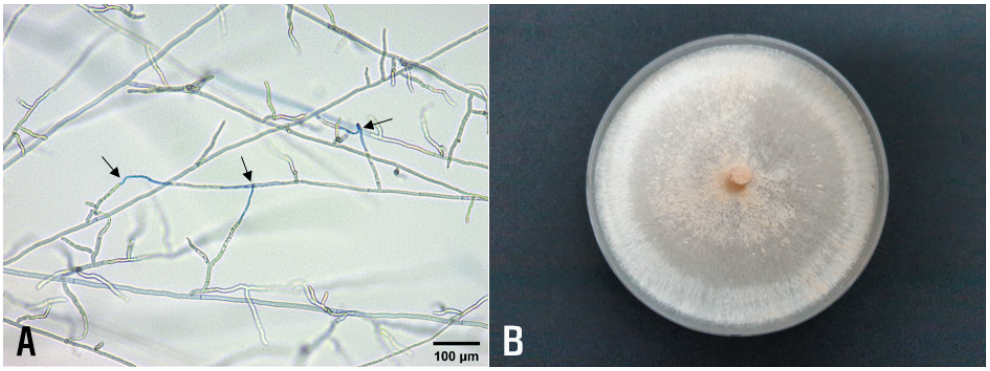

Fig. 2. Anastomosis test of *Rhizoctonia solani* isolate from bonnet bellflower and cultural appearance of the isolate. A: Anastomosis reactions between the tested isolate (left) and the tester isolate (right) of *R. solani* AG-4 observed by compound microscope. The arrows indicate points of hyphal anastomosis. B: A colony of *R. solani* AG-4 isolate grown on potato dextrose agar at 25℃ for 10 days.

All tested isolates of *R. solani* AG-4 induced stem rot symptoms in the inoculated plants (Figs. 1D and 1E), but no symptoms were observed in the control plants (Fig. 1F). The symptoms induced by the artificial inoculation of plants were similar to those observed in plants from the investigated field. The inoculated isolates were re-isolated from the lesions.

R. solani causes various diseases in many crops [6-8], and anastomosis groups of the fungus have different genetic and pathological characteristics [3]. Stem rot on bonnet bellflower caused by *R. solani* has previously been recorded in Korea [9]. However, there has been no report of disease incidence elsewhere. In addition, the anastomosis groups and pathogenicity of *R. solani* isolates from bonnet bellflower have not been previously reported. This is the first report of *R. solani* AG-4 causing stem rot in bonnet bellflower.

ACKNOWLEDGEMENTS

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REFERENCES

1. Plants of the World Online. *Codonopsis lanceolata* (Siebold & Zucc.) Benth. & Hook.f. ex Trautv. [Internet]. Kew: Royal Botanic Garden; 2022 [cited 2022 February 25]. Available from https://powo.science.kew.org/.
2. Parmeter JR Jr., Whitney HS. Taxonomy and nomenclature of the imperfect state. In: Parmeter JR Jr., editor. *Rhizoctonia solani*: Biology and Pathology. Berkeley: University of California Press; 1970. p. 7-19.
3. Sneh B, Burpee L, Ogoshi A. Identification of *Rhizoctonia* Species. The American Phytopathological Society, St. Paul, Minnesota, USA: APS Press; 1991.
4. Kim WG, Cho WD, Lee YH. Anastomosis groups and cultural characteristics of *Rhizoctonia solani* isolates from crops in Korea. Kor J Mycol 1994;22:309-24.
5. Kim WG, Shim HS, Lee GB, Cho WD. Damping-off of edible Amaranth caused by *Rhizoctonia solani* AG-4. Kor J Mycol 2020;48:325-8.
6. Kim WG. Pathogenicity of anastomosis groups and cultural types of *Rhizoctonia solani* isolates on crops. Korean J Plant Pathol 1996;12:21-32.
7. Kim WG, Cho WD, Ryu HY. Diagnosis and Control of Rhizoctonia Diseases on Crops (in Korean). National Agricultural Science and Technology Institute, Suwon, Korea; 1995.
8. Farr DF, Rossman AY. Fungal databases [Internet]. Washington, D.C., U.S. National Fungus Collections, ARS, USDA; 2022 [cited 2022 February 25]. Available from https://nt.ars-grin.gov/fungaldatabases/.
9. Kim WG, Koo HM, Kim KH, Hyun IH, Hong SK, Cha JS, Lee YK, Kim KH, Choi HS, Kim, DG et al. List of Plant Diseases in Korea. 5th ed. Suwon: The Korean Society of Plant Pathology; 2009.