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Pathogenicity of Anastomosis Groups and Cultural Types of *Rhizoctonia solani* on Crops

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*Rhizoctonia solani*의 균사융합군 및 배양형별 작물에 대한 병원성

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ABSTRACT : Pathogenicity of each anastomosis group and cultural type of *Rhizoctonia solani* isolates on 72 species of host crops was examined by inoculation test. Anastomosis groups and cultural types singly isolated from 33 crops were strongly pathogenic to the host crops, those from 8 crops weakly or strongly pathogenic, and those from 6 crops weakly or not pathogenic. Anastomosis groups and cultural types concurrently isolated from 25 species of crops were mostly different or occasionally similar in pathogenicity on the host crops. AG-1(IA) caused leaf blight or leaf rot and sheath blight on the host crops except one. AG-1(IB) caused damping-off and leaf blight or leaf rot on 19 species of the host crops but induced weak or no symptom on 9 species of the host crops. AG-1(IC) caused damping-off and bottom rot or leaf rot on 2 species of *Brassica*. AG-2-1 caused damping-off, bottom rot, crown rot, bud rot, root rot and leaf blight on the host crops except one. AG-2-2(IIIB) caused root and stem rot, sheath blight, damping-off and petiole rot on the host crops. AG-2-2(IV) caused damping-off, crown rot, stem rot and Rhizoctonia blight on the host crops. AG-3 caused black scurf on *Solanum tuberosum*. AG-4 caused various diseases on 42 species of the host crops but induced weak symptoms on 3 species of the host crops. AG-5 caused damping-off, bud rot and sheath blight on 4 species of the host crops but induced weak or no symptom on 9 species of the host crops.

***Key words* : *Rhizoctonia solani*, anastomosis group, cultural type, pathogenicity.**

Rhizoctonia solani Kühn causes various diseases on a large number of crops. Pathogenicity of *R. solani* on the crops differs depending on the fungus strains which have been classified into several anastomosis groups or cultural types (20, 21, 23, 24, 25, 28). Some anastomosis groups or cultural types of *R. solani* have a wide host range, but certain ones have a very narrow host range (26, 28). Occasionally there is some difference in pathogenicity among isolates within an anastomosis group or a cultural type (10~13). Crop cultivars also may affect pathogenicity of the isolates.

Anastomosis groups AG-1 to AG-10 and AG-BI of *R. solani* have been reported throughout the world (1, 3, 16, 19, 21, 22, 23). Cultural types IA, IB and IC exist in the isolates of AG-1, and cultural types IIIB and IV in the isolates of AG-2-2 (4, 28). Kim *et al.* (14) reported that there were six anastomosis groups and five cultural types in the isolates from 68 species of crops in Korea. Pathogenicity of the anastomosis groups and cultural types on some host crops has been examined (7~13). However, there has been no systematic study on pathogenicity of the anastomosis groups and cultural types on all the host crops reported in Korea. This study was conducted to reveal the pathogenicity of every anastomosis group and cultural type on the host crops.

MATERIALS AND METHODS

Isolates. One to four isolates per anastomosis

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group or cultural type of *R. solani* were used for pathogenicity test. The isolates were selected among isolates from crops of which sources were listed in the previous report (14). More isolates obtained from *Angelica jaluana* Nakai, *Brassica oleracea* L. var. *capitata* L., *Capsicum annuum* L., *Cichorium endivia* L., *Cyperus exaltatus* Retz. ssp. *iwasakii* Mak., *Dianthus chinensis* L., *Gomphrena globosa* L., *Lycopersicon esculentum* Mill. var. *cerasiforme* (Dunal) A. Gray, *Verbena phlogiflora* Cham. and *Zingiber officinale* Rosc. were added for the test, which were newly isolated from the crops in 1995.

Crop cultivation. Seventy two species of crops were used for pathogenicity test. One to four cultivars for each host crop were grown in 1/5000-a Wagner pots with sterile soil under greenhouse conditions at 16~30°C. Sometimes small plastic pots (16×7×7 cm) were used for the test of some crops at the seedling stage.

Inoculum. Each isolate was cultured on potato dextrose agar (PDA) in 9-cm-diameter Petri dishes at 24~26°C for mycelial inoculation and in PDRC medium (100 ml of potato dextrose broth and 30 g of rice chaff) in a 500-ml flask at 22~28°C for 40 days for soil inoculation.

Pathogenicity test. Inoculation to each host crop was performed in three replicates in the greenhouse. Mycelial inoculation was used for the test of pathogenicity to leaves and leaf sheaths of crops. Mycelial disks of 6 mm in diameter obtained from the margins of actively growing cultures of each isolate on PDA were placed on the leaves or leaf sheaths. PDA disks were used for the control. The inoculated pots were placed in a chamber with 100% relative humidity at 22~26°C for 48 hr, then returned to the greenhouse. Disease rating was made 5 to 10 days after inoculation.

Soil inoculation was used for the test of pathogenicity to seedlings, stems, roots, crowns, petioles or bulbs of crops. Inoculation to the seedlings was made by putting 20~40 g inoculum in each pot. The same quantity of PDRC medium was used for the control. The inoculated pots were placed in a chamber with 100% relative humidity at 22~26°C for 48 hr, then returned to the greenhouse. Disease rating was made 5 to 15 days after inoculation. For inoculation to plant parts except seedlings, surface soil around the plant was dug by a depth of 2~3 cm, and 40 g of each inoculum was placed around the plant parts. The inoculated plant parts were covered with the original soil. The same quantity of PDRC medium was used for the control. The inoculated pots were placed in the greenhouse and watered once or twice a day. Disease rating was made 10 to 30 days after inoculation.

Disease rating. Disease rating at the seedling stage of crops was determined based on percentage of diseased seedlings. Weak pathogenicity indicated that 1~20% of seedlings were diseased, and strong pathogenicity indicated that 21~100% of seedlings were diseased. Disease rating on the leaves, stems, roots, etc. was determined based on severity of symptoms induced. Weak pathogenicity indicated that a few symptoms developed on the plant parts, but the infected plant grew vigorously. Strong pathogenicity indicated that a lot of symptoms developed on the plant parts, and occasionally the infected plant died.

RESULTS

Pathogenicity of each anastomosis group and cultural type of *R. solani* isolates on 72 species of host crops is shown in Table 1. Anastomosis groups and cultural types singly isolated from 33 crops were strongly pathogenic to the host crops, those from 8 crops weakly or strongly pathogenic, and those from 6 crops weakly or not pathogenic. Anastomosis groups and cultural types concurrently isolated from 25 species of crops were mostly different or occasionally similar in pathogenicity on the host crops.

Diseases and severity on the host crops inoculated with each anastomosis group and cultural type of *R. solani* isolates are shown in Table 2. AG-1(IA) caused leaf blight or leaf rot and sheath blight on 6 species of the host crops but induced weak or no symptom on *Solanum tuberosum* L. AG-1(IB) caused damping-off and leaf blight or leaf rot on 19 species of the host crops but induced weak or no symptom on 9 species of the host crops. AG-1(IC) caused damping-off and bottom rot or leaf rot on 2 species of *Brassica* but induced no symptom on *Chaenomeles sinensis* Koehne. AG-2-1 caused damping-off, bottom rot, crown rot, bud rot, root rot and leaf blight on 10 species of the host crops but induced weak symptoms on *Capsicum annuum* L. AG-2-2(IIIB) caused root and stem rot, sheath blight, damping-off and petiole rot on the host crops. AG-2-2(IV) caused damping-off, crown rot, stem rot and Rhizoctonia blight on the host crops. AG-3 caused black scurf on *Solanum tuberosum* L. AG-4 caused various diseases on 42 species of the host crops but in-

Table 1. Pathogenicity of anastomosis groups and cultural types of *Rhizoctonia solani* isolates on 72 species of host crops tested by artificial inoculation

Host	Plant part inoculated	Anastomosis group (cultural type)	No. of isolates tested	Pathogenicity
Achyranthes japonica Nakai	Stem	AG-4	2	+++[a]
Agrostis palustris Huds.	Leaf blade, leaf sheath	AG-1(IB)	3	+++
Allium cepa L.	Seedling	AG-4	3	+++
Allium fistulosum L.	Seedling	AG-1(IB)	2	+
		AG-4	2	+++
		AG-5	2	++
Angelica dahurica Benth. et Hook.	Stem, root	AG-2-2(IIIB)	2	+++
Angelica jaluana Nakai	Stem, root	AG-1(IB)	2	–
		AG-2-2(IIIB)	4	+++
		AG-2-2(IV)	3	+++
		AG-4	2	++
Antirrhinum majus L.	Seedling	AG-4	2	+++
Arachis hypogaea L.	Leaf	AG-1(IA)	2	+++
		AG-4	2	+
		AG-5	1	–
Arctium lappa L.	Root	AG-4	2	++
Astragalus membranaceus Bunge	Stem	AG-4	2	++
Brassica campestris L. ssp.	Seedling	AG-1(IB)	3	–
pekinensis (Lour.) Olss.		AG-1(IC)	3	+++
		AG-2-1	3	++
		AG-4	3	+++
	Leaf	AG-1(IB)	3	–
		AG-1(IC)	3	++
		AG-2-1	3	++
		AG-4	3	++
	Root	AG-1(IB)	3	–
		AG-1(IC)	3	–
		AG-2-1	3	–
		AG-4	3	++
Brassica oleracea L. var. *botrytis* L.	Seedling, stem	AG-2-1	2	+++
Brassica oleracea L. var. *capitata* L.	Seedling	AG-1(IB)	2	+
		AG-1(IC)	2	+++
		AG-4	2	+++
		AG-5	1	+
	Leaf	AG-1(IB)	2	+++
		AG-1(IC)	2	+++
		AG-4	2	+
		AG-5	1	–
	Root	AG-1(IB)	2	–
		AG-1(IC)	2	–
		AG-4	2	+++
		AG-5	1	–
Bupleurum scorzoneraefolium Will. var. *stenophyllum* Nakai	Stem	AG-1(IB)	2	+
Calendula officinalis L.	Seedling	AG-4	2	+++
Callistephus chinensis Nees.	Seedling	AG-4	2	+++
Capsicum annuum L.	Seedling	AG-1(IB)	2	++
		AG-2-1	2	+
		AG-4	2	+++

Table 1. Continued

Host	Plant part inoculated	Anastomosis group (cultural type)	No. of isolates tested	Patho-genicity
Chaenomeles sinensis Koehne	Root	AG-1(IC)	2	−
Chrysanthemum coronarium L.	Seedling	AG-4	2	+++
Chrysanthemum morifolium Ram.	Leaf	AG-1(IB)	2	+++
	Root	AG-1(IB)	2	+
Cichorium endivia L.	Leaf	AG-1(IB)	3	+++
Citrullus lanatus (Thunb.)	Seedling	AG-1(IB)	2	−
Matsum. et Nakai		AG-2-2(IIIB)	3	−
		AG-4	3	+++
	Stem, root	AG-1(IB)	2	+
		AG-2-2(IIIB)	3	++
		AG-4	3	+++
Cnidium officinale Mak.	Stem	AG-1(IB)	2	−
		AG-4	2	+
		AG-5	2	+
Codonopsis lanceolata Traut.	Stem	AG-1(IB)	2	− or +
Cucumis melo L.	Seedling	AG-4	2	+++
	Stem	AG-4	2	++
Cucumis sativus L.	Seedling	AG-1(IB)	2	+++
		AG-4	2	+++
	Stem	AG-1(IB)	2	− or +
		AG-4	2	+++
Cucurbita moschata Duch.	Seedling	AG-1(IB)	2	++
		AG-4	2	+++
		AG-5	1	++
	Stem	AG-1(IB)	2	+
		AG-4	2	++
		AG-5	1	+
Cyperus exaltatus Retz. ssp. *iwasakii* Mak.	Leaf sheath	AG-1(IA)	2	+++
		AG-2-2(IIIB)	2	++
Daucus carota L. var. *sativa* Dc.	Seedling	AG-1(IB)	2	−
		AG-2-2(IV)	4	+++
	Crown	AG-1(IB)	2	−
		AG-2-2(IV)	4	+++
Dianthus caryophillus L.	Stem	AG-4	3	++
Dianthus chinensis L.	Seedling	AG-4	2	+++
Eustoma russellianum (Hook.) G. Don	Leaf	AG-4	2	+++
Eutrema wasabi Maxim.	Crown	AG-2-1	2	+++
Fragaria x *ananassa* Duch.	Crown	AG-2-1	3	++
		AG-5	3	++
Gerbera jamesonii Bolus.	Crown	AG-4	2	++
Glycine max Merr.	Stem, root	AG-5	2	−
Godetia amoena Lilj.	Stem	AG-5	2	+
Gomphrena globosa L.	Seedling	AG-4	2	+++
Gypsophila elegans M. Bieb.	Stem	AG-2-2(IV)	2	++
		AG-4	2	++
Iris hollandica Hort.	Bulb	AG-5	2	−
Lactuca sativa L.	Leaf	AG-1(IB)	2	+++
		AG-2-1	2	+++
		AG-4	2	+++
Lactuca sativa L. var. *capitata* L.	Leaf	AG-1(IB)	2	+++
		AG-4	1	+++

Table 1. Continued

Host	Plant part inoculated	Anastomosis group (cultural type)	No. of isolates tested	Patho-genicity
Lilium longiflorum Thunb.	Stem	AG-4	2	++
Lithospermum erythrorhizon Sieb. et Zucc.	Leaf	AG-1(IB)	2	+++
		AG-4	2	+++
	Stem	AG-1(IB)	2	+
		AG-4	2	+++
Lupinus perennis L.	Seedling	AG-4	2	+++
Lycopersicon esculentum Mill.	Seedling	AG-4	3	+++
	Stem	AG-4	3	++
Lycopersicon esculentum Mill. var.	Seedling	AG-4	3	+++
cerasiforme (Dunal) A. Gray	Stem	AG-4	3	+
Malva verticillata L.	Seedling	AG-2-1	2	++
Monstera deliciosa Liebm.	Leaf	AG-1(IB)	2	+++
Nicotiana tabacum L.	Seedling	AG-1(IB)	3	+++
Oryza sativa L.	Leaf sheath	AG-1(IA)	4	+++
Ostericum koreanum (Max.) Kitag.	Leaf	AG-1(IB)	2	+++
Panax ginseng Meyer	Seedling	AG-1(IB)	2	++
		AG-2-1	3	++
		AG-4	2	+++
		AG-5	2	+
Petunia hybrida Vilm.	Seedling	AG-4	2	+++
Peucedanum japonicum Thunb.	Leaf	AG-1(IB)	2	+++
		AG-2-2(IIIB)	2	−
	Root	AG-1(IB)	2	+
		AG-2-2(IIIB)	2	+++
Phlox subulata L.	Leaf	AG-1(IB)	2	+++
Pinus densiflora Sieb. et Zucc.	Seedling	AG-4	2	+++
Platycodon grandiflorum A. Dc.	Seedling, stem	AG-1(IA)	3	+
		AG-1(IB)	3	+
		AG-2-2(IIIB)	3	+++
		AG-4	3	+++
	Leaf	AG-1(IA)	3	+++
		AG-1(IB)	3	+++
		AG-2-2(IIIB)	3	−
		AG-4	3	+++
Ranunculus asiaticus L.	Root	AG-2-1	2	++
Raphanus sativus L.	Seedling	AG-1(IA)	3	−
		AG-1(IB)	3	+
		AG-2-1	3	+
		AG-4	3	+++
	Leaf	AG-1(IA)	3	+++
		AG-1(IB)	3	+++
		AG-2-1	3	+
		AG-4	3	++
	Root	AG-1(IA)	3	−
		AG-1(IB)	3	− or +
		AG-2-1	3	++
		AG-4	3	++
Rehmannia glutinosa Libosch. var. *purpurea* Mak. ex Nem.	Root	AG-4	2	+++
Salvia splendens Ker.	Seedling	AG-4	2	+++

Table 1. Continued

Host	Plant part inoculated	Anastomosis group (cultural type)	No. of isolates tested	Pathogenicity
Schindapsus pictus Hassk. var. *argyraeus* Engl.	Petiole	AG-2-2(IIIB)	2	+++
		AG-4	2	+++
Sesamum indicum L.	Seedling	AG-4	2	+++
Solanum melongena L.	Seedling	AG-4	2	+++
Solanum tuberosum L.	Stem	AG-1(IA)	2	+
		AG-3	3	+
		AG-4	4	++
		AG-5	2	+
	Tuber	AG-1(IA)	2	−
		AG-3	3	++
		AG-4	4	+
		AG-5	2	+
Spinacia oleracea L.	Seedling	AG-4	2	+++
Tulipa gesneriana L.	Leaf	AG-2-1	3	++
Verbena phlogiflora Cham.	Leaf	AG-1(IB)	3	+++
Zea mays L.	Leaf sheath	AG-1(IA)	2	+++
		AG-1(IB)	1	+
		AG-2-2(IIIB)	2	++
		AG-4	2	+
		AG-5	2	+
	Root	AG-1(IA)	2	−
		AG-1(IB)	1	+
		AG-2-2(IIIB)	2	++
		AG-4	2	−
		AG-5	2	−
Zingiber officinale Rosc.	Leaf sheath	AG-2-2(IIIB)	2	++
		AG-5	2	++
Zoysia japonica Steud.	Leaf blade, leaf sheath, stolon, root	AG-2-2(IV)	4	+++

[a] +++ : strongly pathogenic, ++ : weakly or strongly pathogenic depending on the isolates or host cultivars, + : weakly pathogenic, − : not pathogenic.

Table 2. Disease severity on 72 species of crops inoculated with anastomosis groups and cultural types of *Rhizoctonia solani* isolates

Anastomosis group (cultural type)	Host	Disease	Severity
AG-1(IA)	*Arachis hypogaea*	Leaf blight	+++[a]
	Cyperus exaltatus ssp. *iwasakii*	Sheath blight	+++
	Oryza sativa	Sheath blight	+++
	Platycodon grandiflorum	Damping-off	+
		Leaf rot	+++
		Stem rot	+
	Raphanus sativus	Dampling-off	−
		Leaf blight	+++
		Rhizoctonia root rot	−
	Solanum tuberosum	Black scurf	− or +
	Zea mays	Sheath blight	+++
		Root rot	−

Table 2. Continued

Anastomosis group (cultural type)	Host	Disease	Severity
AG-1(IB)	*Agrostis palustris*	Rhizoctonia blight	+++
	Allium fistulosum	Damping-off	+
	Angelica jaluana	Stem rot	−
	Brassica campestris ssp. *pekinensis*	Damping-off	−
		Bottom rot	−
		Rhizoctonia root rot	−
	Brassica oleracea var. *capitata*	Damping-off	+
		Leaf rot	+++
		Rhizoctonia root rot	−
	Bupleurum scorzoneraefolium var. *stenophyllum*	Stem rot	+
	Capsicum annuum	Damping-off	++
	Chrysanthemum morifolium	Leaf rot	+++
		Root rot	+
	Cichorium endivia	Leaf rot	+++
	Citrullus lanatus	Damping-off	−
		Root and stem rot	+
	Cnidium officinale	Stem rot	−
	Codonopsis lanceolata	Stem rot	− or +
	Cucumis sativus	Damping-off	+++
		Stem rot	− or +
	Cucurbita moschata	Damping-off	++
		Stem rot	+
	Daucus carota var. *sativa*	Damping-off	−
		Crown rot	−
	Lactuca sativa	Bottom rot	+++
	Lactuca sativa var. *capitata*	Bottom rot	+++
	Lithospermum erythrorhizon	Leaf rot	+++
		Stem rot	+
	Monstera deliciosa	Leaf rot	+++
	Nicotiana tabacum	Damping-off	+++
	Ostericum koreanum	Leaf rot	+++
	Panax ginseng	Dampling-off	++
	Peucedanum japonicum	Leaf blight	+++
		Root rot	+
	Phlox subulata	Leaf blight	+++
	Platycodon grandiflorum	Damping-off	+
		Leaf rot	+++
		Stem rot	+
	Raphanus sativus	Damping-off	+
		Leaf blight	+++
		Rhizoctonia root rot	− or +
	Verbena phlogiflora	Leaf rot	+++
	Zea mays	Sheath blight	+
		Root rot	+
AG-1(IC)	*Brassica campestris* ssp. *pekinensis*	Damping-off	+++
		Bottom rot	++
		Rhizoctonia root rot	−
	Brassica oleracea var. *capitata*	Damping-off	+++
		Leaf rot	+++
		Rhizoctonia root rot	−

Table 2. Continued

Anastomosis group (cultural type)	Host	Disease	Severity
	Chaenomeles sinensis	Root rot	–
AG-2-1	*Brassica campestris* ssp. *pekinensis*	Damping-off	++
		Bottom rot	++
		Rhizoctonia root rot	–
	Brassica oleracea var. *botrytis*	Damping-off	+++
	Capsicum annuum	Damping-off	+
	Eutrema wasabi	Crown rot	+++
	Fragaria x *ananassa*	Bud rot	++
	Lactuca sativa	Bottom rot	+++
	Malva verticillata	Damping-off	++
	Panax ginseng	Damping-off	++
	Ranunculus asiaticus	Root rot	++
	Raphanus sativus	Damping-off	+
		Leaf blight	+
		Rhizoctonia root rot	++
	Tulipa gesneriana	Leaf blight	++
AG-2-2(IIIB)	*Angelica dahurica*	Root and stem rot	+++
	Angelica jaluana	Stem rot	+++
	Citrullus lanatus	Damping-off	–
		Root and stem rot	++
	Cyperus exaltatus	Sheath blight	++
	Peucedanum japonicum	Leaf blight	–
		Root rot	+++
	Platycodon grandiflorum	Damping-off	+++
		Leaf rot	–
		Stem rot	+++
	Schindapsus pictus var. *argyraeus*	Petiole rot	+++
	Zea mays	Sheath blight	++
		Root rot	++
	Zingiber officinale	Sheath blight	++
AG-2-2(IV)	*Angelica jaluana*	Stem rot	+++
	Daucus carota var. *sativa*	Damping-off	+++
		Crown rot	+++
	Gypsophila elegans	Stem rot	++
	Zoysia japonica	Rhizoctonia blight	+++
AG-3	*Solanum tuberosum*	Black scurf	++
AG-4	*Achyanthes japonica*	Stem rot	+++
	Allium cepa	Damping-off	+++
	Alllium fistulosum	Damping-off	+++
	Angelica jaluana	Stem rot	++
	Antirrhinum majus	Damping-off	+++
	Arachis hypogaea	Leaf blight	+
	Arctium lappa	Root rot	++
	Astragalus membranaceus	Stem rot	++
	Brassica campestris ssp. *pekinensis*	Damping-off	+++
		Bottom rot	++
		Rhizoctonia root rot	++
	Brassica oleracea var. *capitata*	Damping-off	+++
		Leaf-rot	+
		Rhizoctonia root rot	+++

Table 2. Continued

Anastomosis group (cultural type)	Host	Disease	Severity
	Calendula officinalis	Damping-off	+++
	Callistephus chinensis	Damping-off	+++
	Capsicum annuum	Damping-off	+++
	Chrysanthemum coronarium	Damping-off	+++
	Citrullus lanatus	Damping-off	+++
		Root and stem rot	+++
	Cnidium officinale	Stem rot	+
	Cucumis melo	Damping-off	+++
		Stem rot	++
	Cucumis sativus	Damping-off	+++
		Stem rot	+++
	Cucurbita moschata	Damping-off	+++
		Stem rot	++
	Dianthus caryophillus	Stem rot	++
	Dianthus chinensis	Damping-off	+++
	Eustoma russellianum	Leaf rot	+++
	Gerbera jamesonii	Rhizoctonia crown rot	++
	Gomphrena globosa	Damping-off	+++
	Gypsophila elegans	Stem rot	++
	Lactuca sativa	Bottom rot	+++
	Lactuca sativa var. *capitata*	Bottom rot	+++
	Lilium longiflorum	Stem rot	++
	Lithospermum erythrorhizon	Leaf rot	+++
		Stem rot	+++
	Lupinus perennis	Damping-off	+++
	Lycopersicon esculentum	Damping-off	+++
		Stem canker	++
	Lycopersicon esculentum var. *cerasiforme*	Damping-off	+++
		Stem canker	+
	Panax ginseng	Damping-off	+++
	Petunia hybrida	Damping-off	+++
	Pinus densiflora	Damping-off	+++
	Platycodon grandiflorum	Damping-off	+++
		Leaf rot	+++
		Stem rot	+++
	Raphanus sativus	Damping off	+++
		Leaf blight	++
		Rhizoctonia root rot	++
	Rehmannia glutinosa var. *purpurea*	Root rot	+++
	Salvia splendens	Damping-off	+++
	Schindapsus pictus var. *argyraeus*	Petiole rot	+++
	Sesamum indicum	Damping-off	+++
	Solanum melongena	Damping-off	+++
	Solanum tuberosum	Black scurf	++
	Spinacia oleracea	Damping-off	+++
	Zea mays	Sheath blight	+
		Root rot	−
AG-5	*Allium fistulosum*	Damping-off	++
	Arachis hypogaea	Leaf blight	−
	Brassica oleracea var. *capitata*	Damping-off	+

Table 2. Continued

Anastomosis group (cultural type)	Host	Disease	Severity
		Leaf rot	−
		Rhizoctonia root rot	−
	Cnidium officinale	Stem rot	+
	Cucurbita moschata	Damping-off	++
		Stem rot	+
	Fragaria x *ananassa*	Bud rot	++
	Glycine max	Root and stem rot	−
	Godetia amoena	Stem rot	+
	Iris hollandica	Bulb rot	−
	Panax ginseng	Damping-off	+
	Solanum tuberosum	Black scurf	+
	Zea *mays*	Sheath blight	+
		Root rot	−
	Zingiber officinale	Sheath blight	++

[a] +++ : severe symptoms, ++ : weak to severe symptoms, + : weak symptoms, − : no symptom.

duced weak symptoms on *Arachis hypogaea* L., *Cnidium officinale* Mak. and *Zea mays* L. AG-5 caused damping-off, bud rot and sheath blight on 4 species of the host crops but induced weak or no symptom on 9 species of the host crops.

DISCUSSION

Anastomosis groups and cultural types of *R. solani* are specific in pathogenicity on crops. They have characteristic host ranges, and their pathogenicity on the host crops differs depending on the plant parts. It has been reported that cultural types IA and IB of AG-1 inhabit on aerial parts of plants (28). The present study also reveals that AG-1 mostly attacks aerial parts of the host crops. Among three cultural types of AG-1, IB has the widest host range but is not pathogenic to some host crops. AG-1(IC) is mildly virulent (26) or causes damping-off on a variety of hosts (4, 6). It causes damping-off and bottom rot or leaf rot on *Brassica campestris* L. ssp. *pekinensis* (Lour.) Olss. and *Brassica oleracea* L. var. *capitata* L. in Korea.

It has been reported that AG-2-1 inhabits on ground surface of crops (28). The present study shows that the anastomosis group attacks subterranean parts of some host crops as well as the ground surface of most host crops. AG-2-1 grows well at low temperatures, and attacks winter crops (14, 21, 26, 28). Many kinds of crops have been cultivated in vinyl-housed fields during the cold season in Korea. The cool and humid conditions in the vinyl-housed fields may be favorable to occurrence of diseases caused by AG-2-1 on the host crops.

Cultural types IIIB and IV of AG-2-2 mostly have strong pathogenicity on the host crops. The two cultural types correspond to the rush type and root rot type designated by Watanabe and Matsuda (28), respectively. However, their pathological characteristics examined in this study are somewhat different from those reported by the previous workers in terms of disease occurrence on the plant parts. Cultural type IIIB is a high temperature group (14, 26, 28) and mostly causes root and stem rot on host crops. Diseases on the host crops caused by this group may be increased during summer. Cultural type IV has a relatively narrower host range than cultural type IIIB, and its temperature range for mycelial growth is slightly lower than cultural type IIIB (14). This group causes damping-off, crown rot, stem rot and Rhizoctonia blight on host crops.

AG-3 is a slightly low temperature group and causes black scurf on *S. tuberosum* (14, 26, 28). The anastomosis group attacks a few crops besides *S. tuberosum*, and the infection on the crops is sometimes initiated by basidiospores (2, 15, 17). In addition, the anastomosis group has been isolated from sugar beet seedlings (18) and lettuce (27). In Korea, AG-3 was isolated from only *S. tuberosum* (14), suggesting that the anastomosis group has a very narrow host range.

Among the anastomosis groups tested in this study,

AG-4 has the widest host range, and causes various diseases on host crops. The anastomosis group has been defined as a praticola type causing damping-off of crops (28). There have been nonpathogenic isolates in the anastomosis group from soils (5). The present study reveals that AG-4 is mostly pathogenic to the host crops tested except a few crops. Accordingly it is suggested that density of AG-4 in crop fields may be the highest among the anastomosis groups.

AG-5 has been considered to be a weak pathogen on crops (26). The present study also reveals that the anastomosis group is weakly or not pathogenic to most of the host crops tested.

요 약

Rhizoctonia solani 균주들의 각 균사융합군 및 배양형별 72종의 기주작물에 대한 병원성을 접종실험에 의해 조사하였다. 33종의 작물에서 단독으로 분리된 균사융합군 및 배양형은 그 기주작물에 병원성이 강하였으며, 8종의 작물에서 단독으로 분리된 것들은 병원성이 약하거나 강하였고, 6종의 작물에서 단독으로 분리된 것들은 병원성이 약하거나 없었다. 26종의 작물에서 같이 분리된 균사융합군 및 배양형은 그 기주작물에 대한 병원성이 대부분 다르거나 간혹 비슷했다. AG-1(IA)는 1종을 제외한 기주작물에 잎마름병 혹은 잎썩음병과 잎집무늬마름병을 일으켰다. AG-1(IB)는 19종의 기주작물에 잘록병과 잎마름병 혹은 잎썩음병을 일으켰으나, 9종의 기주작물에는 병징을 약하게 유발시키거나 혹은 유발시키지 못했다. AG-1(IC)는 2종의 유채속작물에 잘록병과 밑둥썩음병 혹은 잎썩음병을 일으켰다. AG-2-1은 1종을 제외한 기주작물에 잘록병, 밑둥썩음병, 관부썩음병, 눈마름병, 뿌리썩음병, 잎마름병을 일으켰다. AG-2-2(IIIB)는 기주작물에 뿌리 및 줄기썩음병, 잎마름병, 잘록병, 잎자루썩음병을 일으켰다. AG-2-2(IV)는 기주작물에 잘록병, 관부썩음병, 줄기썩음병, 라이족토니아마름병을 일으켰다. AG-3은 감자에 검은무늬썩음병을 일으켰다. AG-4는 42종의 기주작물에 여러 가지 병을 일으켰으나, 3종의 기주작물에는 병징을 약하게 유발시켰다. AG-5는 4종의 기주작물에 잘록병, 눈마름병, 잎집무늬마름병을 일으켰으나, 9종의 기주작물에는 병징을 약하게 유발시키거나 혹은 유발시키지 못했다.

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