Occurrence of Binucleate *Rhizoctonia* spp. on Azalea and Spatial Analysis of Web Blight in Container-Grown Nursery Stock

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ABSTRACT

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Binucleate *Rhizoctonia* spp. were isolated from potting media, from symptomatic leaves of rooted azalea cuttings in propagation houses, and from container-grown azaleas at two nurseries in North Carolina. Thirty-one of 38 selected isolates of binucleate *Rhizoctonia* spp. from potting media were pathogenic on azalea. Propagule density of all *Rhizoctonia* spp. in potting medium in 15-cm-diameter containers of azaleas in production areas ranged from <1.0 to approximately 6.0 propagules per gram in both years of the study. The incidence of web blight in container-grown azaleas at nursery 1 in 1986 ranged from <1% on day 191 (early in the production season) to 51% on day 283. Spatial pattern of symptomatic azaleas in 1986, as determined by goodness-of-fit to discrete frequency distributions, was random at low disease incidence and became more aggregated as incidence increased. Two-dimensional distance class analysis also revealed a higher frequency of infected pairs of plants and a greater degree of clustering of diseased plants as disease incidence increased. Inoculum density of *Rhizoctonia* spp. in the container media and disease incidence of azaleas were not correlated.

Binucleate *Rhizoctonia* spp. isolated recently from the foliage of azaleas with web blight in production nurseries were pathogenic in greenhouse experiments (8). Sources of inoculum of these binucleate *Rhizoctonia* spp. in azalea production nurseries are not known but may consist of rain-splashed sclerotia, mycelia in organic debris (9), or basidiospores (5).

Analysis of the spatial pattern of symptomatic azaleas in production nurseries may provide information on the source and spread of inoculum of *Rhizoctonia* spp. The spatial pattern of diseased plants may vary along a continuum from regular or random to

Web blight is an important foliar disease of container-grown azaleas (*Rhododendron* sp.) in the southeastern United States. Symptoms of the disease include discrete lesions on the leaves and leaf necrosis, primarily within the internal portions of the plant canopy. Diseased leaves abscise but remain attached to the plant stem by webs of mycelial growth. Azaleas with a compact growth habit, such as the dwarf Satsuki hybrids, are highly susceptible to web blight. Epidemics of web blight in production nurseries or enclosed propagation houses may develop when warm temperatures and high relative humidity prevail. A foliar disease caused by *Rhizoctonia solani* Kühn caused severe defoliation of 150,000 azaleas in Florida during periods of warm, humid weather in 1966 (23).
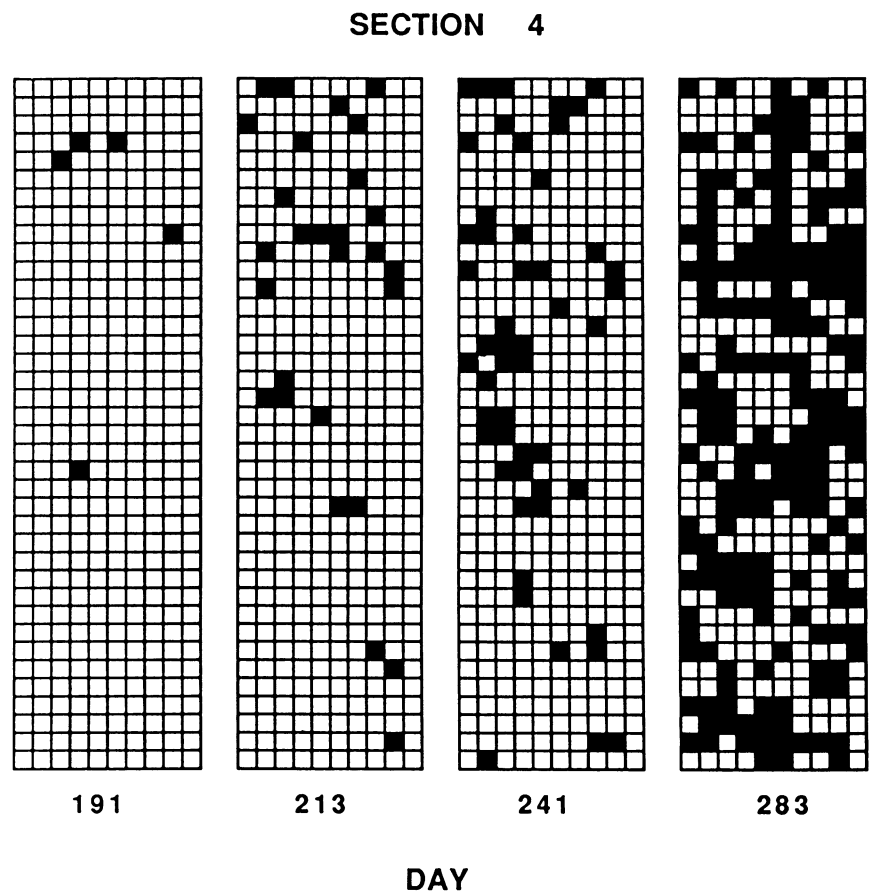
SECTION 4

191   213   241   283

DAY

Fig. 1. Disease progress at nursery 1 in 1986 from day 191 (6 June) to day 283 (10 October). Black squares represent azaleas with symptoms of web blight, and white squares represent healthy plants.

highly aggregated (4). A random pattern suggests primary spread of inoculum from a source outside the container area. Aggregation or clustering of infected plants may indicate secondary spread of the pathogen within a section of containers (16). Phytophthora dieback was aggregated in nurseries of container-grown azaleas (2), indicating that secondary infection from inoculum disseminated to adjacent containers may have occurred.

The relationship of inoculum density to the incidence of web blight in container-grown nursery stock has not been determined. Inoculum density of *Rhizoctonia* spp. and root disease severity have been correlated in several studies (3,19,20,22), but Martin et al (18) found no significant relationship between soil populations of *Rhizoctonia* spp. and the severity of foliar disease on turfgrasses.
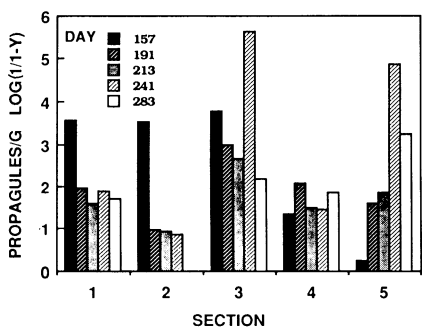

Fig. 2. Mean inoculum levels of *Rhizoctonia* spp. in five sections of Satsuki azalea cv. Gumpo at nursery 1 in 1986. Removal of plants in section 2 precluded calculation of inoculum density on day 283.
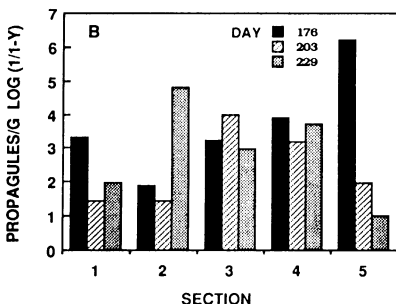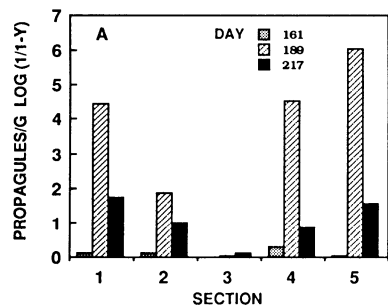

Fig. 3. Mean inoculum levels of *Rhizoctonia* spp. in five sections of Satsuki azalea cv. Gumpo at **(A)** nursery 1 in 1987 and **(B)** nursery 2 in 1987.

The objectives of this study were to describe the spatial pattern of web blight incidence in container-grown azaleas, to determine the density of inocula of *Rhizoctonia* spp. in potting media, and to determine the relationship between inoculum density and the incidence of web blight of azalea.

MATERIALS AND METHODS

Nurseries sampled. Studies were performed in two nurseries in eastern North Carolina growing Satsuki azalea (*Rhododendron* sp. 'Gumpo'). At both locations, azaleas in 15-cm-diameter containers were placed on black polypropylene mesh ground cover and were irrigated by overhead sprinklers. Azaleas at nursery 1 were grown under 50% shade material in 1986 and in full sun in 1987. Container-grown azaleas at nursery 2 were grown under natural shade from pine trees in both years. Plants sampled at both nurseries were rooted either on the premises or by a propagator and were in the first growing season when sampled.

Determination of inoculum density of *Rhizoctonia* spp. A multiple soil-pellet sampler (13) was used to place subsamples (media pellets) of container media (0.078 cm^3) collected from bulk piles, rooted cuttings, or 15-cm-diameter containers onto Flower's medium (FM) (7) amended with $0.05\,\mu$g a.i./ml of benomyl. After 48 hr of incubation, plates were inspected for mycelia with characteristics of the form-genus *Rhizoctonia* DC. (21). The assay was considered positive if 10 or more hyphae grew out of a single pellet (12,13). Additional media pellets were dried at 40 C for 24 hr to determine the average dry weight of the pellet samples. The numbers of propagules of *Rhizoctonia* spp. per sample of potting medium were estimated from the percentage of pellets colonized by applying the first order of the Poisson distribution log$_e$ $(1/1-y)$ (13), where y signifies the proportion of *Rhizoctonia*-positive pellets. Numbers of propagules of *Rhizoctonia* spp. per sample were expressed on a per gram dry weight basis.

Early season samples. Healthy azalea leaves and leaves with brown-black lesions and necrosis typical of web blight were collected arbitrarily from the foliage

and soil surfaces of rooted cuttings growing in propagation houses and from container-grown azaleas in production areas. Leaves were placed onto FM, and after 48 hr of incubation, plates were inspected for mycelia of *Rhizoctonia* spp.

Pine bark, peat moss, and sand used in container media as well as samples of the formulated medium (3:1:1, v/v) were collected from bulk piles at each nursery early in the season (6 March 1986, 24 April 1987) before rooted cuttings were transplanted into 15-cm-diameter containers. Subsamples of media were placed onto FM with the multiple-pellet sampler. The proportion of media pellets from which mycelia of the form-genus *Rhizoctonia* had originated was determined.

Soil assay for rooted cuttings. Potting medium (peat moss and perlite, 1:1, v/v) was collected from flats of rooted cuttings (36 plants per flat) in enclosed propagation houses. Thirty to 45 flats of plants were sampled systematically from one of every 10 flats at nursery 1 in 1986 and 1987 and at nursery 2 in 1987. In 1986, rooted cuttings at nursery 2 were obtained from a propagator and were not sampled before being transplanted into 15-cm-diameter containers. Samples were collected from the upper 1.0–2.0 cm of potting medium near 10 arbitrarily selected plants per flat at each nursery. Forty-five subsamples per sample were placed onto FM with the multiple soil-pellet sampler. Inoculum density in each sample was determined as described above.

Soil assay for 15-cm-diameter containers. Samples were collected from the upper 2.0–2.5 cm of potting medium (pine bark, peat moss, and sand, 3:1:1, v/v) in 15–20 randomly selected containers in each of five sections of azaleas at each nursery. Soil samples were bagged separately and carried to the laboratory for analysis. Samples were sieved through a 5-mm-mesh screen. Particles <5 mm in diameter (fraction I) and particles ≥5 mm in diameter (fraction II) were assayed separately for *Rhizoctonia* spp. Seventy-five subsamples per sample of fraction I were placed onto FM (five plates, 15 pellets per plate) with the multiple soil-pellet

Table 1. Frequency of various nuclear conditions of hyphal cells of *Rhizoctonia* spp. from azalea leaves and potting media at nurseries 1 and 2

	Number of nuclei per cell				
Source of sample	2	2-3[a]	2-4[a]	3	>4
Potting media					
Rooted cuttings	23[b]	5	1	1	0
Containers, 15-cm-diam.	95	20	4	3	1
Symptomatic leaves	14	4	1	0	0
Total	132	29	6	4	1

[a] Isolates with predominantly binucleate hyphal cells but occasionally possessing hyphal cells with three or four nuclei per cell.
[b] Number of isolates having the described number of nuclei in hyphal cells.

sampler. Inoculum density in each sample was estimated as described above.

Approximately 2 g of each sample of fraction II (pine bark pieces and organic matter) was placed as discrete units onto FM. An equal weight of each sample was oven-dried at 40 C for 24 hr. Numbers of propagules of *Rhizoctonia* spp. in each sample of fraction II were calculated on the basis of the proportion of pieces of pine bark and organic debris colonized by *Rhizoctonia* spp., and counts were expressed on a per gram dry weight basis.

The total number of propagules of *Rhizoctonia* spp. per gram dry weight of potting medium for each sample was determined by adding the numbers of propagules per gram in fraction I and fraction II. Inoculum density was calculated in this manner each month for samples of potting media collected from container-grown azaleas at nursery 1 from day (day of year) 157 (6 June) to day 283 (10 October) in 1986 and from day 162 (11 June) to day 217 (5 August) in 1987. Inoculum density was calculated for samples of potting media collected at nursery 2 each month from day 157 (6 June) to day 231 (19 August) in 1986 and from day 176 (25 June) to day 229 (17 August) in 1987.

Characterization and pathogenicity of selected isolates. Mycelia typical of the form-genus *Rhizoctonia* were transferred from colonized soil pellets, organic matter, and symptomatic leaves to potato-dextrose agar for further identification. The number of nuclei in hyphal tip cells of each of 172 selected isolates was determined using the DNA binding flurochrome, 4',6'-diamidino-2-phenyl-indole (DAPI), according to the procedure of Martin (17).

Thirty-eight randomly selected isolates were tested for pathogenicity on 6-mo-old Satsuki azalea cv. Gumpo. Isolates were grown on autoclaved bran (121 C, 15 psi, 60 min, two consecutive days) for 10–14 days. Approximately 2.0 g of the

infested bran was placed on the soil surface at the base of three replicate plants per treatment. Plants were incubated in humidity chambers (1.01 m^3 capacity) for 5 days, then were rated for disease severity on a scale of 0–4, where 0 = a healthy plant and 1 = 1–25%, 2 = 26–50%, 3 = 51–75%, and 4 = 76–100% of the foliage diseased. The test was repeated, with similar results.

Quadrat sampling technique. Azaleas in 15-cm-diameter containers at nursery 1 were arranged in sections of plants 10 containers wide by 38–40 containers long, for a total of 380–400 plants per section. Plants in nursery 2 were arranged in sections six containers wide by 70 containers long, for a total of 420 plants per section. Spacing between the

containers at both nurseries varied from 0 to 6 cm down rows of plants and from 5 to 11 cm between rows of plants. Adjoining sections of azaleas were separated by walkways 0.4–0.6 m wide.

Each of 10 randomly selected sections of azaleas at nursery 1 was divided into 35 contiguous quadrats (5 × 7 quadrats). A quadrat within a section consisted of two adjacent rows of five plants each. Ten randomly selected sections of azaleas at nursery 2 were divided into 42 quadrats (3 × 14 quadrats). Each plant in the 10 sections at both nurseries was inspected visually for web blight at monthly intervals throughout the production season. Plants were assigned a status of healthy, symptomatic, or missing. The position of each symptomatic plant
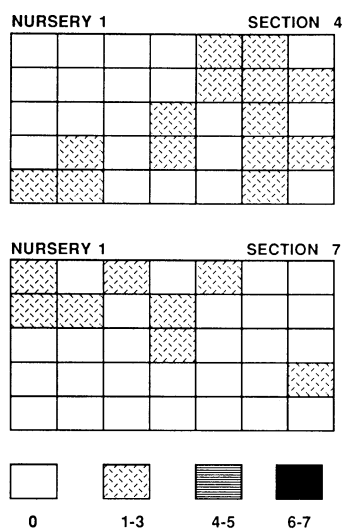
NUMBER OF SYMPTOMATIC PLANTS / QUADRAT

Fig. 4. Spatial pattern of symptomatic Satsuki azalea cv. Gumpo on day 213 in 1986 in two sections of azaleas at nursery 1. Sections were divided into 35 quadrats of 10 plants each. Sections 4 and 7 had 6.6 and 3.0% symptomatic plants, respectively, whose spatial pattern was best described as random.
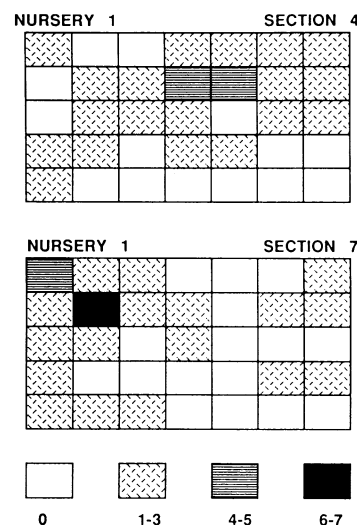
NUMBER OF SYMPTOMATIC PLANTS / QUADRAT

Fig. 5. Spatial pattern of symptomatic Satsuki azalea cv. Gumpo on day 241 in 1986 in two sections of azaleas at nursery 1. Sections were divided into 35 quadrats of 10 plants each. Sections 4 and 7 had 12.4 and 11.8% symptomatic plants, respectively, whose spatial pattern was best described as aggregated.

Table 2. Disease incidence, values for indices of dispersion, and goodness of fit to the Poisson or negative binomial frequency distribution for symptomatic azaleas at nursery 1 in 1986

Section[a]	Symptomatic plants (%)		Variance-to-mean ratio[b]		Morisita's index[b]		Poisson[c]		Negative binomial[c]		*k* Value	
	213[d]	241	213	241	213	241	213	241	213	241	213	241
1	1.0	4.3	0.94	1.28	0.00	1.79	NS	NS	NF	NS	NF	1.54
2	1.8	5.3	0.88	1.26	0.00	1.47	NS	*	NF	NS	NF	1.69
3	4.4	24.5	1.55*	2.13*	2.33*	1.44**	NS	*	NS	NS	0.73	1.73
4	6.6	12.4	1.16	1.58*	1.29	1.46*	NS	NS	NS	NS	3.49	2.03
5	11.0	37.2	0.35	1.17	0.18	1.04	**	NS	NF	NS	NF	26.03
6	6.0	11.8	1.06	1.10	1.10	1.09	NS	NS	NS	NS	18.47	12.56
7	3.0	11.8	0.99	1.89**	0.97	1.84**	NS	*	NF	NS	NF	1.23
8	6.6	38.7	0.79	1.31	0.70	1.08	NS	*	NF	*	NF	15.35
9	11.0	19.5	2.17**	1.64*	2.02**	1.31*	*	*	NS	*	0.77	1.88
10	11.0	25.3	0.46	0.93	0.34	0.97	NS	NS	NF	NF	NF	NF

[a] Each consisting of 380–400 15-cm-diameter containers of Satsuki azalea cv. Gumpo.
[b] A value of 1.0 indicates random dispersion and a value significantly greater than 1.0 indicates aggregation of diseased plants; * and ** indicate values significantly greater than 1.0 at $P = 0.05$ and $P = 0.01$, respectively.
[c] Data are fit by the frequency distribution when χ^2 values are not significant (NS) at $P = 0.05$. NF = not fit, * = significant ($P= 0.05$).
[d] Day of year.

within a section was mapped, and frequency tables were constructed for the number of diseased plants in each quadrat.

Analysis of data. Data for intermediate levels of disease incidence at nursery 1 (days 213 and 241) in 1986 were tested for goodness-of-fit to the Poisson and negative binomial discrete frequency distributions using a FORTRAN computer program (10). The Poisson distribution describes a random spatial pattern of diseased plants for which the sample variance is approximately equal to the sample mean. The negative binomial distribution describes an aggregated or clustered spatial pattern for which the sample variance is significantly greater than the sample mean. Morisita's index of dispersion and the variance-to-mean ratio (6) were also calculated for quadrat data for each section of plants. A value of 1.0 for Morisita's index implies randomness of symptomatic plants, whereas values greater than 1.0 imply aggregation. A value of 1.0 for the variance-to-mean ratio implies a random spatial pattern and agreement with the Poisson series,

whereas values greater than 1.0 imply an aggregated or clustered spatial pattern of diseased plants.

Data for disease incidence on days 213 and 241 in 1986 in five randomly selected sections of azaleas at nursery 1 were also analyzed by the two-dimensional distance class method (11). The two-dimensional distance class method estimates the randomness of infected plants and describes the orientation of infected plants (down columns, across rows, and diagonally) within a section. All plants within a section were assigned a horizontal (X) and vertical (Y) value based on the location of the plants within the 10 column $\times$ 38–40 plant section. Absolute value differences between (X) and (Y) values for infected pairs of plants were calculated by FORTRAN computer programs, and all pairs of infected plants within a section were assigned an $[X, Y]$ distance class (11). The counts of pairs of infected plants in each $[X, Y]$ distance class, calculated from observed data, were standardized by comparing actual data to the number of possible pairs in each distance class, calculated using computer-generated simulation data.

Standard deviations for standardized counts in each distance class and 95% confidence limits for each significance level were calculated by the computer program.

RESULTS

Disease recognition and incidence. Web blight was first observed on container-grown azaleas at nursery 1 on day 191 (10 July) in 1986, and disease incidence increased throughout the production season (Fig. 1). Disease incidence in 10 sections at nursery 1 ranged from 0.0–3.8% on day 191 to 25.0–51.0% on day 283 (10 October). On symptomatic azaleas, webs of mycelia were observed on the surfaces of container media and on foliage near the container surface. Plant-to-plant infection occurred among closely spaced azaleas within and between rows by direct mycelial growth. Hymenial layers, indicative of the sexual state of the form-genus *Rhizoctonia*, were not observed on the container medium, stems, or leaves of symptomatic plants. In 1987, web blight was not observed until later in the production season (day 273) at nursery 1. Disease incidence and severity were very low in 1987, and disease incidence data were not analyzed. Web blight was not observed at nursery 2 in either year of the study.

Isolations from potting media and inoculum density. *Rhizoctonia* spp. were detected in the potting media of 13.3 and 45.0% of the flats of rooted cuttings sampled at nursery 1 in 1986 and 1987, respectively. Inoculum densities in the potting media of rooted cuttings at nursery 1 were low in both years of the study, ranging from 0 to 0.68 propagules of *Rhizoctonia* spp. per gram of potting media (ppg) in 1986 and from 0 to 1.01 ppg in 1987. At nursery 2 in 1987, 57% of the samples of potting media collected from flats of rooted cuttings were colonized by *Rhizoctonia* spp. Inoculum densities in rooted cuttings at nursery 2 ranged from 0 to 2.13 ppg.

Rhizoctonia spp. were not isolated from samples of potting medium in bulk piles in potting areas or from apparently healthy azalea leaves at either nursery in 1986 or 1987.

Average inoculum densities of *Rhizoctonia* spp. in 15-cm-diameter containers of azaleas at nursery 1 ranged from 0.26 to 5.65 ppg in 1986 and from 0.01 to 6.06 ppg in 1987 (Figs. 2 and 3A). Average inoculum levels were variable over time in the five sections sampled at nursery 1 in 1986 (Fig. 2), whereas average inoculum levels at nursery 1 in 1987 were lowest on day 161 and highest on day 189 relative to other sample dates (Fig. 3A). Average inoculum levels in 15-cm-diameter containers of azaleas at nursery 2 were nil or very low in 1986; in 1987, however, inoculum levels at nursery 2 ranged from 1.02 to 6.20 ppg and were
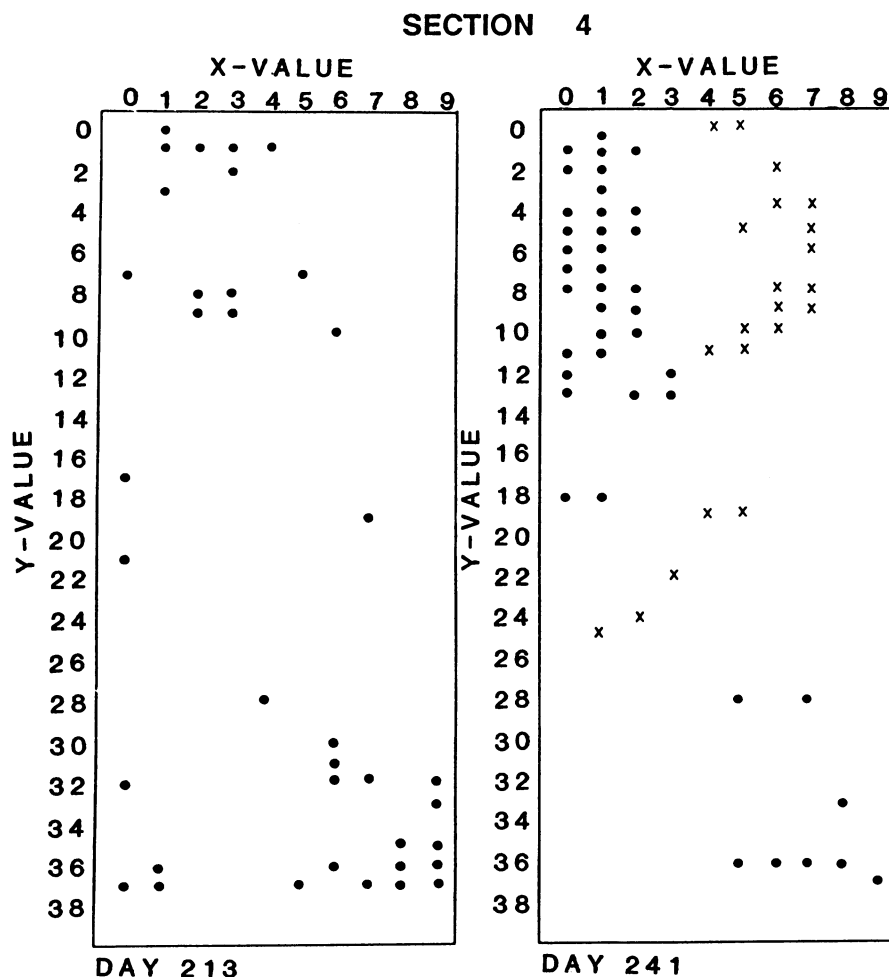

Fig. 6. Two-dimensional distance class analysis of azaleas in section 4 at nursery 1 on days 213 and 241 in 1986. ● = Distance class with a significantly higher $(P \leqslant 0.05)$ number of infected pairs of plants than expected under a random distribution, and X = distance class with a significantly lower $(P \geqslant 0.95)$ number of infected pairs of plants than expected.

variable over time in the five sections sampled (Fig. 3B).

Isolation and identification of *Rhizoctonia* spp. Most (97.1%) of the *Rhizoctonia*-like fungi isolated from symptomatic leaves and from potting medium in flats of rooted cuttings and 15-cm-diameter containers possessed binucleate hyphal cells and were identified as binucleate *Rhizoctonia* spp. (Table 1). Some of these isolates were predominantly binucleate but occasionally possessed hyphal cells with three or four nuclei per cell (Table 1). One of the 172 isolates of *Rhizoctonia* spp. collected possessed multinucleate hyphal cells and was identified as *R. solani* (Table 1).

Pathogenicity studies. Thirty-one of 38 selected isolates caused foliar necrosis on 25–50% of the foliage of test plants after 5 days of incubation in the humidity chambers. Mean disease severity ratings of these isolates ranged from 1.3 to 2.3. Seven of 38 isolates produced abundant mycelial growth on the test plants but had lower disease severity ratings (0.5–1.0) than the other isolates tested.

Inoculum density of *Rhizoctonia* spp. and disease incidence were not correlated ($P \geqslant 0.17$) in any section of container-grown azaleas evaluated at nursery 1 in 1986.

Spatial pattern analysis. The spatial pattern of symptomatic plants at nursery 1 on day 213 (Fig. 4) was judged not to be different from random, because the data were best described by the Poisson distribution (Table 2). The Poisson distribution was not different from data for 80% of the sections on day 213, whereas the negative binomial was not different from data for 40% of the sections. In addition, Morisita's index and the variance-to-mean ratio were not significantly greater than 1.0 in 80% of the sections (Table 2), indicating no departure from randomness of infected plants in the sections evaluated. The spatial pattern of symptomatic plants on day 241 (Fig. 5) was judged to be aggregated, because data were best described by the negative binomial distribution. The negative binomial distribution fit 70% of the sections evaluated, whereas the Poisson distribution fit only 50% of the sections (Table 2). Morisita's index of dispersion and the variance-to-mean ratio exceeded unity in 40% of the sections evaluated on day 241 (Table 2), indicating a higher degree of aggregation of infected plants in the sections evaluated on day 241 relative to day 213. The k values of the negative binomial distribution in most sections evaluated on day 241 were below 2.03 (Table 2); small k values indicate aggregation and large k values indicate the distribution approaches randomness (6).

Two-dimensional distance class analysis of disease incidence data at nursery 1 on both day 213 and day 241 in 1986 showed a higher frequency of infected pairs of

plants in the five sections evaluated than expected under the hypothesis of a random distribution of infected plants (Figs. 6 and 7). However, an increase in the frequency and degree of clustering of infected plants was apparent on day 241 relative to day 213 (Figs. 6 and 7). As disease incidence increased, on day 241 more infected plants occurred along rows (distance classes 0, 1–2, 4–8, and 11–13, Fig. 6; distance classes 0, 29–31, and 34–35, Fig. 7), across rows (distance classes 1–3 and 0, Fig. 7), and diagonally across rows (distance class 1,1, Fig. 6) than expected under a hypothesis of random distribution of infected plants. An average of 3.25 distance classes had significantly lower ($P \geqslant 0.95$) frequencies of infected pairs of plants than expected under a hypothesis of a random distribution of infected pairs of plants in the five sections of azaleas evaluated on day 213, whereas on day 241 an average of 26.5 distance classes had significantly lower ($P \geqslant 0.95$) frequencies of infected pairs of plants than expected, providing additional evidence for the presence of clusters of infected plants as disease incidence increased.

DISCUSSION

The occurrence of binucleate *Rhizoctonia* spp. in the potting media and on symptomatic leaves of rooted cuttings in propagation houses early in the production season suggests that infested rooted cuttings may be the primary source of inoculum causing web blight of container-grown azaleas in production areas. Initially, the spatial pattern of symptomatic container-grown azaleas in growing areas was random. The random pattern of diseased plants may indicate spread of the pathogen from a source outside the growing area (16). A random spatial pattern may have occurred in the process of transplanting infested rooted cuttings and unloading infested 15-cm-diameter containers of azaleas from potting areas into the growing areas of the nursery (2).

Aggregation of diseased plants later in the production season is suggestive of secondary spread of the pathogen (11,16). Two-dimensional distance class analysis revealed increased clustering of diseased plants as the incidence of web blight increased and the occurrence of symptomatic azaleas down rows, across
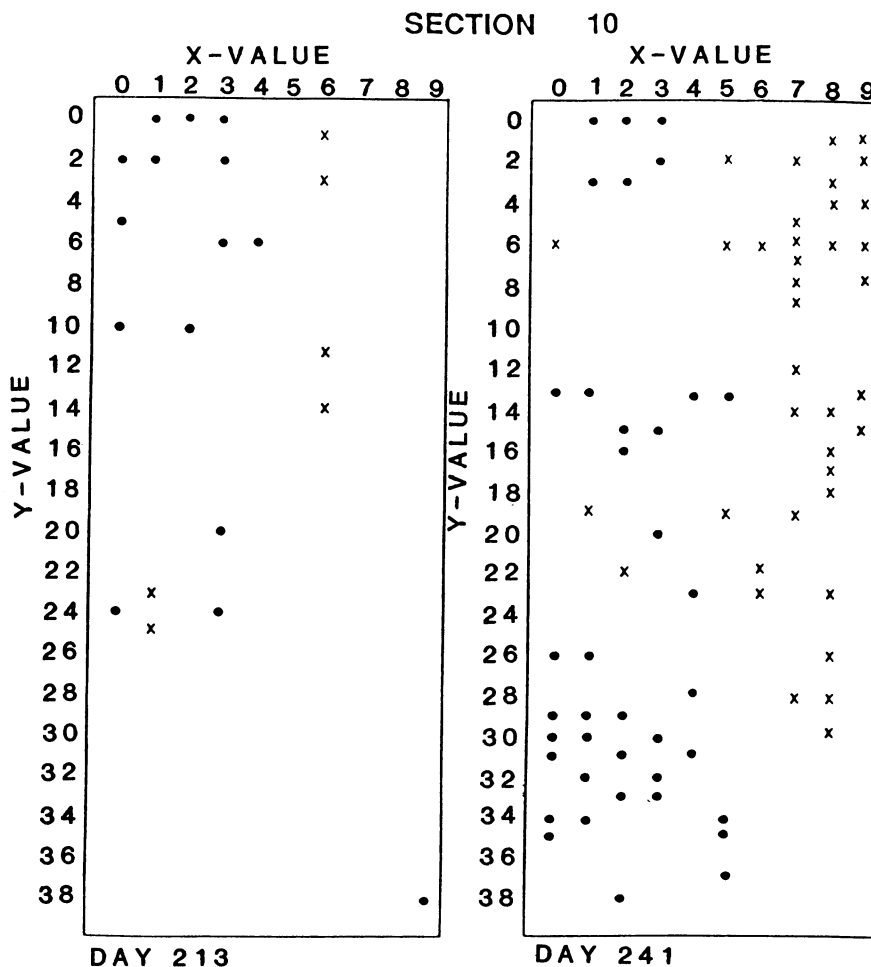

Fig. 7. Two-dimensional distance class analysis of azaleas in section 10 at nursery 1 on days 213 and 241 in 1986. ● = Distance class with a significantly higher ($P \leqslant 0.05$) number of infected pairs of plants than expected under a random distribution, and X = distance class with a significantly lower ($P \geqslant 0.95$) number of infected pairs of plants than expected.

rows, and diagonally between rows within sections. These results were expected, as 15-cm-diameter containers were closely spaced within sections and contact of foliage and plant-to-plant infection occurred through direct mycelial growth from previously infected leaves. Dispersal of *Rhizoctonia* spp. by direct mycelial growth from infected leaves of bean and turfgrass has been reported (9,15). Rain or irrigation may also splash-disperse sclerotia or mycelia of *Rhizoctonia* spp. (9,24). Although basidiospores have been reported as inoculum on other hosts (5,14), no basidial hymenia were observed in this study. Apparently, basidiospores were not a source of secondary inoculum in the spread of web blight of azalea under the conditions of our study.

The poor correlation between inoculum density of *Rhizoctonia* spp. in the potting media and incidence of web blight at nursery 1 indicated that disease incidence could not be predicted from relative amounts of *Rhizoctonia* spp. in the potting media. Levels of *Rhizoctonia* spp. in the potting media were similiar at nursery 1 in both years of the study. In 1986, however, incidence of web blight at nursery 1 reached maximum levels of 51%, whereas little or no disease occurred in 1987. At nursery 2 in 1987, no disease developed even though inoculum levels were similiar to those at nursery 1 in 1986 and 1987. Other factors being constant, disease severity should reflect inoculum levels in the soil (1). However, inoculum density is modified both by environmental factors and by the inherent ability of an organism to cause disease (1). Martin et al (18) suggested that heterogeneity of species and relative virulence of *Rhizoctonia* spp. accounted for the lack of correlation between inoculum density and foliar blight of turfgrasses. Most isolates of binucleate *Rhizoctonia* spp. in this study, however, were virulent on azalea.

The poor correlation between inoculum density and disease incidence suggests that the development of web blight and subsequent spread of inoculum of *Rhizoctonia* spp. to adjacent plants within nursery sections may depend on favorable environmental conditions. More web blight may have developed at nursery 1 in 1986 relative to 1987 because environmental conditions in growing areas favored disease development in 1986 but not in 1987. Plants were grown in the shade at nursery 1 in 1986, so moisture from irrigation or rain water may have remained on the foliage for extended periods of time, thus favoring disease development. In 1987, azaleas in nursery 1 were grown in full sun, which probably resulted in higher canopy temperatures, lower relative humidities, and a shorter duration of leaf wetness within the plant canopy, thus providing unfavorable conditions for disease development. In addition, low rainfall and lack of prolonged periods of cloudiness in 1987 relative to 1986 may have provided unfavorable conditions for web blight in 1987. The lack of rainfall and cloudiness in 1987 may explain why web blight did not develop at nursery 2 in 1987 even though plants were grown in the shade and inoculum was present at levels similiar to those at nursery 1.

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