亜熱帯産マツ類のマツノザイセンチュウに対する罹病性

誌名	日本林學會誌 = Journal of the Japanese Forestry Society
ISSN	0021485X
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巻/号	66巻11号
掲載ページ	p. 465-468
発行年月	1984年11月

日林誌 66(11)'84 465～468

短　報

Susceptibility of Subtropical Pine Species and Provenances to the Pine Wood Nematode*

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I. Introduction

Two-needle pines, *Pinus densiflora* S. et Z. (Japanese red pine) and *P. thunbergii* PARL (Japanese black pine) are native to Japan and have wide natural distributions. However, as reviewed by KOBAYASHI (1981) a mass killing of these pines by the pine wood nematode, *Bursaphelenchus xylophilus* (STEINER and BUHRER, 1934) NICKLE 1970 (NICKLE *et al.* 1981) has prevailed in southwestern Japan since the decade of the 1940's. A vector insect, *Monochamus alternatus* HOPE (Japanese pine sawyer) was discovered by MORIMOTO and IWASAKI (1972). The nematode was once described by MAMIYA and KIYOHARA (1972) as *B. lignicolus*, but NICKLE and others (1981) reported that the pine wood nematode populations in Japan and the U. S. A. are the same species after genetic crosses and indicated that there was a wide distribution of the species in the U. S. A.

Meanwhile, in tropical and subtropical regions, some pine species such as *P. caribaea* MORELET and *P. oocarpa* SCHIEDE are planted extensively for the production of timber and industrial materials. Therefore, it is useful to have information on the susceptibility of pine species to the pine wood nematode as a precaution for the protection of these pines.

II. Materials and Methods

Besides three subtropical pine species, namely, *P. caribaea*, *P. oocarpa*, and *P. pseudostrobus* LINDL., each with ten provenances as shown in Table 1, were supplied by the Forestry Department of Oxford University, the two Japanese pine species, *P. densiflora* and *P. thunbergii*, and *P. massoniana* LAMB., were treated with the last three as checks. *P. massoniana* has a high crossability with Japanese pines as reported by NAKAI and others (1967), and the hybrid between *P. thunbergii* and *P. massoniana* was found to be highly resistant to the pine wood nematode by SASAKI and FURUKOSHI (1976), and *P. massoniana* itself also was reported resistant (FUTAI and FURUNO, 1978).

The seeds were sown in plastic containers 48 cm long, 33 cm wide, and 10 cm deep each filled with clayey soil in a greenhouse in the spring of 1981. Resulting seedlings were divided into two groups, namely, those transplanted into plastic containers and those planted directly into the ground in the greenhouse. Each group had two replications with transplants numbering 3 to 31 varying by provenances. The containers with pines were kept under shade in an open-sided greenhouse where they were expected to be cooler than the ground transplanted pines, especially in summer time.

In July, two-year-old plants were inoculated with cultivated nematodes, *B. xylophilus*, isolate stock No. S6-1 supplied by the Forest Pathology Laboratory, Kyushu Branch, Forestry and Forest Products Research Institute, in thinly barked portions of their main stems with a knife. Five-thousand nematodes in water suspensions were applied to each plant in the containers in July 1982, and 10,000 nematodes were applied to the ground planted ones in the greenhouse in August 1982.

One month after the inoculation, the symptoms of the nematode infection appeared showing wilting, then browning of the needles, and eventually, the death of the plants. The sound plants were counted in September.

III. Results and Discussion

The counts of the sound plants are shown for each replication in the two transplanted groups. Because of severe drought and higher air and soil temperatures for the ground-planted group, almost all of the plants inoculated were dead. In the container-planted group, the species clearly differed in the number of sound plants. For statistical analysis, only the container-planted group was used after anarcs in transfomation of the percentages of the sound plants, with the exemption of *P. massoniana* as it was a check. The results are shown in Table 2. There is a highly significant difference among species but not between provenances within

* 大庭喜八郎・古越隆信・栗延　晋・石井克明: 亜熱帯産マツ類のマツノザイセンチュウに対する罹病性
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Table 1. Pine species tested, their provenances, and ratios of sound to total of tested plants after inoculation of the pine wood nematode

Species	Lot. No.	Provenance	Sound plant/tested plant				Percentage[1] of sound plants	
			Container plant		Ground plant			
			I	II	I	II	I	II
P. caribaea	1	Pinar del Rio, Cuba	0/26	1/23	0/10	0/10	0	4.3
	2	High Rock, Grand Bahama	0/25	0/23	0/14	0/14	0	0
	3	Karawala, Nicaragua	0/21	1/19	0/14	0/11	0	5.3
	4	Alamicamba, Nicaragua	0/18	1/17	0/10	0/11	0	5.9
	5	Santa Clara, Nicaragua	0/20	0/17	0/ 8	0/ 9	0	0
	6	Brus Lagoon, Honduras	0/14	0/17	0/ 7	0/ 9	0	0
	7	Guanaja, Honduras	2/22	0/18	0/12	0/10	9.1	0
	8	Los Limones, Honduras	0/19	0/19	0/10	0/ 7	0	0
	9	Poptun, Guatemala	0/22	0/23	0/ 8	0/ 9	0	0
	10	Belize, Mountain Pine Ridge	2/20	1/19	0/13	0/ 8	10.0	5.3
P. oocarpa	11	Bonete, Nicaragua	5/27	1/17	0/16	0/10	18.5	5.9
	12	Yucul, Nicaragua	1/24	0/17	0/ 9	0/ 7	4.2	0
	13	Dipilto, Nicaragua	2/22	0/14	0/16	0/ 9	9.1	0
	14	Angeles, Honduras	1/18	3/17	0/13	0/ 5	5.6	17.6
	15	Siguatepeque, Honduras	2/22	2/17	0/15	0/12	10.0	11.8
	16	La Union, Honduras	4/21	1/18	0/14	0/ 7	19.0	5.6
	17	Huehuetenango, Guatemala	7/20	1/20	0/17	0/10	35.0	5.0
	18	Mal Paso, Guatemala	1/18	2/11	0/12	0/ 5	5.6	18.2
	19	El Pinalon, Guatemala	6/20	2/20	0/14	0/ 4	30.0	10.0
	20	Belize, Mountain Pine Ridge	3/21	1/16	0/ 9	0/ 9	14.3	6.3
P. pseudostrobus	21	Volcan Yali, Nicaragua	4/25	0/15	0/16	0/ 5	16.0	0
	22	Dipilto, Nicaragua	1/10	0/15	—	0/ 3	10.0	0
	23	Jinotega, Nicaragua	2/22	0/24	0/15	0/ 9	9.1	0
	24	Loma de Ochoa, Honduras	2/21	1/20	0/14	0/ 7	9.5	5.0
	25	Tatumbla, Honduras	1/23	2/21	0/12	0/11	4.3	9.5
	26	Dulce Nombre, Honduras	0/21	2/18	0/12	0/13	0	11.1
	27	La Fortuna, Honduras	0/13	0/13	0/ 7	0/ 8	0	0
	28	Tecpan, Guatemala	2/26	0/20	0/16	0/11	7.7	0
	29	San Juan, Guatemala	2/18	0/20	0/14	0/17	11.1	0
	30	Rafael, Nicaragua	1/21	0/19	0/17	0/12	9.5	0
P. densiflora[2]	31	Fukushima, Japan	14/24	11/24	0/18	1/19	58.3	45.8
	32	Tochigi, Japan	15/24	21/28	0/18	4/14	62.5	75.0
	33	Gunma, Japan	12/25	3/21	0/16	3/14	48.0	14.3
	34	Ibaraki, Japan	12/24	8/23	0/17	1/17	50.0	34.8
	35	Nagano, Japan	3/25	4/25	0/20	1/12	12.0	16.0
	36	Saitama, Japan	12/26	6/25	0/20	3/17	46.2	24.0
	37	Yamanashi, Japan	1/ 6	2/ 9	—	—	16.7	22.2
	38	Chiba, Japan	22/26	14/23	0/20	1/17	84.5	60.9
	39	Kanagawa, Japan	3/24	1/24	0/19	0/12	12.5	4.2
	40	Shizuoka, Japan	8/21	1/26	0/18	0/ 7	38.1	3.8
P. thunbergii[2]	41	Ibaraki, Japan	2/26	4/30	0/12	0/15	7.7	13.3
	42	Gifu, Japan	1/29	4/28	0/18	0/18	3.4	14.3
	43	Chiba, Japan	0/29	2/22	0/18	0/16	0	9.1
	44	Ibaraki, Japan	2/28	10/23	0/19	0/17	7.1	45.3
	45	Ibaraki, Japan	0/30	0/23	0/18	0/12	0	0
	46	Ibaraki, Japan	6/30	1/22	1/13	0/10	20.0	4.5
	47	Saitama, Japan	1/31	4/25	0/17	0/13	3.2	15.0
P. massoniana	48	Kumamoto, Japan	23/23	21/23	0/12	1/6	100.0	91.3

1) Calculated only for container plants.
2) Plus tree seeds collected from the seed orchard of the Kanto Forest Tree Breeding Institute, Mito, Ibaraki, Japan. The test was made in a greenhouse. I and II are replications.

species indicating that all provenances are equally susceptible to the pine wood nematode except those of *P. densiflora*.

In Table 3, a cross-comparison of the percentages of sound plants is made, and *P. densiflora* shows a slightly lower degree of susceptibility in comparison with other species. *P. caribaea*, *P. pseudostrobus*, *P. oocarpa*, and *P. thunbergii* are equally susceptible.

P. massoniana is highly resistant to the pine wood

Table 2. Variance analysis of the ratios of sound plants in the container transplanting

Source of variance	Degree of freedom	Sum of square	Mean square	F-value
Species	4	5,662.605	1,415.65	13.51**
Provenances within species	42	4,400.394	104.77	2.84**
P. caribaea	9	38.778	4.039	
P. oocarpa	9	194.438	21.604	
P. pseudostrobus	9	29.855	3.317	
P. densiflora	9	3,877.695	430.855	11.66**
P. thunbergii	6	259.629	43.271	
Error	47	1,736.475	36.946	
Total	93	11,799.473		

** Statistically significant at the 1% level
An arcsin transformation was used for the calculation.

Table 3. Statistical test of the ratio of the sound plants among pine species

	P. caribaea	*P. pseudostrobus*	*P. thunbergii*	*P. oocarpa*	*P. densiflora*
Mean ratio of the sound plants (%)	2.28	5.91	8.23	13.38	44.69
P. densiflora	42.41**	38.78**	36.46**	31.31**	
P. oocarpa	11.10NS	7.47NS	5.15NS		
P. thunbergii	5.95NS	2.32NS			
P. pseudostrobus	3.63NS				

** Statistically significant at the 1% level
NS: Not significant

nematode even in this experiment, and *P. densiflora* was the second most-resistant having a fairly large variation in susceptibility.

The damage to pines by the pine wood nematode, pine-wilt disease, has a very close interrelationship with an insect vector, *M. alternatus* in Japan. Therefore, the higher susceptibility of the pine species planted widely in the tropical and subtropical regions does not mean that there is an immediated danger of nematode attack. However, it should be recommended that strict measures must be taken so as not to introduce the pine wood nematode with its vector into areas with extensive plantations of these pine species.

In Japan, as reported by OHBA (1980) and by FUJIMOTO and OHBA (1981), pine tree breeding directed against the pine wood nematode is in progress and is producing promissing red and black pines by intraspecific selection. Another project on resistance breeding by species hybridization between *P. thunbergii* and *P. massoniana* also is being conducted.

Acknowledgment

The authors are grateful to Dr. J. BURLEY and Mr. A. GREAVES, Forestry Department, Oxford University for the supply of seeds, and they also thank Dr. BURLEY for his detailed reading and improvement of the manuscript.

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* Japanese with English summary
** Only in Japanese

(Received May 7, 1984)

学会記事

○昭和 60 年度林学賞，農学賞候補審査委員会の記録（第 2 回）

日　時: 昭和 59 年 9 月 28 日（金） 13:00～15:00

場　所: 林業試験場第 1 会議室

出席者: 勝田委員長。赤羽，栗屋，岡，西川，柳，脇，相場，大庭，井上，金川，藤森，野淵，真宮，秋谷，新田，岩川，大里，小沼の各委員。林学会より豊川総務主事。事務局より清水。

協議内容:

1. 林学賞候補について各部門ごとに審査経過の報告がなされ，その結果，立地部門から 1 論文の推薦があった。当該部門主査より説明を受けた後，この論文を審査対象論文業績とすることにし，その説明者を決定した。

2. 第 3 回審査委員会（最終回）のために，規定により審査委員 5 名の補充委嘱がなされた。

旧	新
赤羽　武（筑波大）	餅田治文（筑波大）
有光一登（林試）	伊藤忠夫（静岡大）
秋谷孝一（林試）	太田猛彦（農工大）
新田隆三（林試）	工藤哲也（林試）
小沼順一（林試）	奥田吉春（林試）

3. 理事会への報告書作成委員を藤森隆郎，真宮靖治両委員に委嘱することが決定した。

4. 農学賞候補についても各部門とも推薦対象論文なしとの報告があった。

5. 林学賞授与規定については，改訂案が検討され，理事会に提出されることになった。

○第 366 回編集委員会の記録

と　き: 昭和 59 年 9 月 4 日（火） 13:00～16:30

ところ: 林業試験場

出席者: 南雲委員長，岡，西川，生原，金沢，森川，八木，鈴木，野淵，小林の各委員。酒井，芝野の両主事。事務局より清水。

議　事: 1) 論文などの審査状況
2) 論文などの審査者の決定
3) 66 巻 9 号，10 号，11 号の掲載論文の承認および決定
4) その他

○第 367 回編集委員会の記録

と　き: 昭和 59 年 10 月 9 日（火） 15:00～17:00

ところ: 日本林業技術協会別館

出席者: 南雲委員長，西川，生原，金沢，横山，森川，八木，鈴木，小林の各委員。酒井，芝野の両主事。事務局より清水。

議　事: 1) 論文などの審査状況
2) 論文などの審査者の決定
3) 66 巻 10 号，11 号，12 号の掲載論文の承認および決定
4) その他