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Mem. Fac. Agr. Kagoshima Univ., **15**, 73–78, 1979

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Received for Publication August 31, 1978

Introduction

The cultivation of rhododendrons is generally difficult, especially this is so in the lowlands of south-western part of Japan, where the summer is exceedingly hot and the radical changes among the rainy and sun scorching, dry windy weathers are prevailing.

In these districts *Rhododendron metternichii* Sieb. et Zuc., one of the species of Ponticum series belonging to the elepidotes, widely distributes, but its natural habitats are confined to the mountain areas generally over 700 m where the summer is cool and moist. There also occurs *R. yakusimanum* Nakai, which belongs to the same series and is peculiarly confined to Yakushima Island, one of the southern islands of Kagoshima Pref., but its natural habitat is also mountain areas generally over 1200 m.

In Japan, some trials to obtain the heat resistant hybrid rhododendrons have been carried out. The works of Koichiro Wada are the most prominent in this field. He has repeatedly emphasized that the heat resistance can be obtained through the heterosis derived from the crossings among different species and/or their garden hybrids, though what kind of cross combination will afford the vigorous seedlings is difficult to predict[3].

The present investigation was undertaken to breed the heat resistant rhododendrons as well as to ascertain the validity of Wada's claim, growing and selecting the seedlings in a glasshouse where the temperatures during the summer frequently rose to 40°C or higher.

Materials and Methods

Open pollinated seeds of *R. metternichii* and hybrid seeds derived from a cross 'Ruby Hart' × *R. metternichii* were sown on Nov. 10, 1976. The former seeds were collected from 3 individuals selected for glossy foliage, all of which were growing wild in Mt. Inugatake in northern Kyushu.

The media on which the seeds were sown were the mixtures of fine pumice (about 0.5 cm in diameter), peat, vermiculite and shredded fine sphagnum moss, the ratio being about 4 : 2 : 2 : 2 by volumes. The uppermost part of the media (about 1 cm in depth) was consisted of fine sphagnum moss only. The seedlings obtained were grown, throughout the winter, under the continuous illumination from the NEC FL40BR BIOLUX fluorescent tubes, which were set 30 cm high and 40 cm apart. The temperatures of the growing room were maintained over 9°C; the averages of daily maximum and minimum temperatures from Dec. 11, 1976

This work was presented at the Spring Meeting of the Japanese Society for Horticultural Science, Utsunomiya, April 7, 1978.

to March 10, 1977 were 21.1 and 13.0° C, respectively.

From April 13 to 16, 1977 the seedlings were transplanted into 36 × 45 × 10 cm plastic boxes. The media used were the mixtures of fine pumice, peat and fine sphagnum moss, the ratio of which was about 6 : 3 : 1 by volumes. The plant interval was about 5.0 × 3.5 cm. The seedlings transplanted were transferred to two situations under natural day length; one in a glasshouse and the other in the open of partial shade where the eaves could intercept the rain and the daily hours, receiving direct sunlight, were about 4.5 hours during the summer season. The glasshouse was covered with a sheet of lawn, Kuremona #600, from July 1 to Nov. 9, 1977. The averages of daily maximum and minimum temperatures from July 16 to Aug. 31, 1977 were 38.5 and 26.3° C for the glasshouse and 31.9 and 23.7° C for the open, respectively.

Liquid fertilizer containing nitrogen, phosphate and potassium, 100 : 70 : 85 ppm was given at about 7 days interval from Jan. 10 to the transplanting in April and at 3 to 4 days interval thereafter, though in the summer, from mid July to early September, the level of fertilizer was lowered to half strength. Insecticide was used if required, but from April no fungicide was used to check the susceptible individuals to various diseases.

The measurements were carried out in Nov. 10 to 13, 1977. The items were the survival or death, the plant size and the degree of leaf trouble. The plant size was the diameter between the leaf tips of the two longest leaves. The degree of leaf trouble was presented by the indices from − to + + + +, which indicated the increasing order of trouble, i.e., −; trouble free, ±; slight trouble in a few leaf tips, +; trouble found about 25 percent of the leaves, + +; about 50 percent of the leaves, + + +; about 75 percent of the leaves, and + + + +; over 95 percent of the leaves. As expected there occurred intermediate leaf troubles, especially in the indices from ± to + + + +. In these cases they were assigned to more

Fig. 1. Growth of the seedlings.
Upper row; Hybrid seedlings, from left to right, the individuals of 8, 10, 12, 14, 16, 18 and 20 cm in diameter, respectively
Lower row; Seedlings of *R. metternichii* 1 (Strain 1), from left to right, those of 2, 4, 6, 8, 10 and 12 cm in diameter, respectively. (Pohtographed on Nov. 8, 1977)

appropriate class, respectively.

Results and Discussion

The results obtained were presented in Tables 1 to 3 for *R. metternichii* and Table 4 for hybrid seedlings. The data were also reconstructed and compiled in Tables 5 and 6 to provide facilities for the direct comparison between *R. metternichii* and hybrid seedlings. As seen in these Tables, the growth of seedlings in the open where the temperatures were comparatively lower, was better than that in the glasshouse, and the reverse was the cases in leaf trouble and plant death.

Table 1. Growth and leaf trouble in the seedlings of *R. metternichii* 1 (Strain IG 1)

Situation	Degree of*1 leaf trouble	Plant size (cm, up to)								No. of seedlings examined	
		2	4	6	8	10	12	14	Total	Survived	Dead
Glasshouse	−		2						2	112 (46.7)*2	128 (53.3)
	±			1	1	1			3		
	+		1	7	10	3			21		
	++		2	17	18	7			44		
	+++		2	13	10	2			27		
	++++		2	8	3	2			15		
	Total		9	46	42	15			112		
Open	−		21	60	69	40	17	1	208	252 (97.3)	7 (2.7)
	±		5	9	7	4	2	1	28		
	+		1	6	2				9		
	++		1	2	1				4		
	+++		1	1	1				3		
	++++										
	Total		29	78	80	44	19	2	252		

*1 See in the text. When severely damaged, the plantlets died.
*2 Numerical values in parentheses represent percentage.

Table 2. Growth and leaf trouble in the seedlings of *R. metternichii* 2 (Strain IG 3)

Situation	Degree of leaf trouble	Plant size (cm, up to)								No. of seedlings examined	
		2	4	6	8	10	12	14	Total	Survived	Dead
Glasshouse	−		9	4					13	702 (41.9)	974 (58.1)
	±		9	14					23		
	+	4	80	92	9	1			186		
	++	5	134	165	7				311		
	+++		43	67	6				116		
	++++		29	23	1				53		
	Total	9	304	365	23	1			702		
Open	−	3	73	127	130	30	3	1	367	479 (94.1)	30 (5.9)
	±		6	24	37	10	1		78		
	+		7	3	10	2	1		23		
	++		3	2		1			6		
	+++			2					2		
	++++		1		2				3		
	Total	3	90	158	179	43	5	1	479		

For details see Table 1.

Table 3. Growth and leaf trouble in the seedlings of *R. metternichii* 3 (Strain IG 4)*

Situation	Degree of leaf trouble	Plant size (cm, up to)								No. of seedlings examined	
		2	4	6	8	10	12	14	Total	Survived	Dead
Glasshouse	−			1					1	71 (11.3)	559 (88.7)
	±										
	+		1						1		
	++		9	16	7				32		
	+++		4	11	3	1			19		
	++++		3	9	4	2			18		
	Total		17	37	14	3			71		

*In this strain, the experiment in the open was not conducted.
For other details see Table 1.

Table 4. Growth and leaf trouble in the seedlings of 'Ruby Hart' × *R. metternichii*

Situation	Degree of leaf trouble	Plant size (cm, up to)											No. of seedlings examined	
		2	4	6	8	10	12	14	16	18	20	Total	Survived	Dead
Glasshouse	−		2	30	53	29	10					124	488 (75.7)	69 (10.7)
	±		4	26	34	23	11	1				99		
	+		5	23	39	16	8	4				95		
	++		7	35	24	21	7	1				95		
	+++		2	12	14	13	6					47		
	++++	1	4	7	9	5	1	1				28		
	CH*		3	9	5	3	1					21	21 (3.2)	67 (10.4)
	Total	1	27	142	178	110	44	7				509		
Open	−			4	28	81	93	61	27	6	2	302	369 (92.0)	9 (2.3)
	±			2	6	18	14	8	8	2	1	59		
	+				1	1	1					3		
	++				1	1	1			1		4		
	+++						1					1		
	++++													
	CH			3	4	10	2		1	1		21	21 (5.2)	2 (0.5)
	Total			9	40	111	112	69	36	10	3	390		

*Individuals with chlorotic leaf.
For other details see Table 1.

Table 5. Compiled and comparative growth features in the seedlings of *R. metternichii* and those of 'Ruby Hart' × *R. metternichii*

Rhododendron	Situation	Plant size (cm, up to)										Survival (%) ratio
		2	4	6	8	10	12	14	16	18	20	
Metternichii*1	Glasshouse	1.1	38.5	50.5	8.0	2.0*2						42.5*2
	Open	0.4	16.3	32.3	35.4	11.9	3.3	0.4				95.2
Hybrid	Glasshouse	0.2	5.3	27.9	35.0	21.6	8.6	1.4				78.9
	Open			2.3	10.2	28.5	28.7	17.7	9.2	2.6	0.8	97.2

*1 Data of *R. metternichii* were compiled from the results of strain IG 1 and 3 and those of IG 4 were omitted.
*2 All numerical values were presented in percentage.

As the temperature rose, some chlorophyll deficient individual occurred in the hybrid seedlings (Tables 4 and 6). These chlorophyll deficiencies were exclusively confined to the

Table 6. Compiled and comparative leaf trouble in the seedlings of *R. metternichii* and those of 'Ruby Hart' × *R. metternichii*

Rhododendron	Situation	Degree of leaf-trouble						
		−	±	+	++	+++	++++	CH
Metternichii	Glasshouse	1.8	3.2	25.4	43.6	17.6	8.4	
	Open	78.7	14.5	4.4	1.4	0.7	0.4	
Hybrid	Glasshouse	24.4	19.4	18.7	18.7	9.2	5.5	4.1
	Open	77.4	15.1	0.8	1.0	0.3		5.4

For details see Table 5.

newly developed leaves during the summer, and as the temperature lowered normal green leaves appeared again. Thus, it was apparent that these deficiencies were dependent on higher temperature. The slightly heavier occurrence of these chloroses in the glasshouse than in the open, might also substantiate the high temperature dependence. In the glasshouse most of the chlorotic leaves burned from leaf tip and eventually died. As seen in Table 4, the survival ratio of plantlets with such leaf trouble was much lower than that in the open, i.e., 23.9 percent for the glasshouse and 91.3 percent for the open.

Some similar phenomena were also encountered in the seedlings of *R. metternichii*. In this case, however, the ratio of these chlorophyll deficient individuals has not been calculated, since the growth of the seedlings of *R. metternichii* during the summer was too much suppressed or stunted to enable us to discriminate the chlorophyll deficient individuals from those with normal green leaves.

Except these chlorophyll deficient individuals, the hybrid seedlings in the glasshouse showed much more vigorous growth and much less leaf trouble and plant death than those of *R. metternichii*, though in the open the growth of the both strains was not so substantially different. In other words, the hybrid seedlings could tolerate much more unfavourable environmental conditions than those of *R. metternichii* and fully demonstrate their potentiality under these circumstances.

The pedigree of 'Ruby Hart' is [(*R. sanguineum* ssp. *didymum* × *R. forrestii* var. *repens*) × (*R. forrestii* var. *repens* × *R. griersonianum*)] × *R. elliottii*. In the lowlands of south-western Japan this cultivar is very fastidious, shows severe leaf troubles and frequently dies. From the classification of the present experiment, it corresponds to the class ++++ or beyond that (died). This fastidiousness of 'Ruby Hart' is due probably to the prevailed involvement of Neriiflorum series, especially of *R. forrestii* var. *repens*, though in some favourable conditions this cultivar displays three or four flushings in one growing season. This repetition of flushings is one of the fascinating characters of this cultivar along with its precocious flowering.

R. metternichii also shows some fastidiousness in the lowlands of south-western Japan, as understood from the present results shown in Tables 1 to 3. In the present experiment, however, there occurred some differences among the seed parents concerned. The heaviest trouble and plant death were encountered in the seedlings of *R. metternichii* 3. Its survival ratio in the glasshouse was only 11.3 percent, as compared with 46.7 and 41.9 percent in the seedlings of *R. metternichii* 1 and 2. In this context, the individual of this species used for the crossing with 'Ruby Hart' for obtaining hybrid seeds belonged to the class + in the cultivation in the open.

In spite of these fastidiousnesses of the parents, their hybrid seedlings showed an incredibly strong growth, i.e., they were much sturdier than either parent and continued to grow under severe circumstances in glasshouse during the summer. Although not presented in Tables, almost all of hybrid seedlings turned into the caulescent type growth, whereas those of *R. metternichii* remained as the acaulescent, rosette type plants throughout the growing season. Although Wada said that it was difficult to predict what kind of cross combination could afford the vigorous seedlings[3], the results obtained here substantiated his assumption that the heat resistant, vigorous offsprings might be obtained from the heterosis.

All species involved in the development of cultivar 'Ruby Hart', have their natural habitats in the neighbouring districts of Upper Burma : *R. sanguineum* Franch.[2], distributes in south-east Tibet and Yunnan, 3400–4400 m; *R. forrestii* Balf.[2], in south-east Tibet, Yunnan and north-east Burma, 3400–4600 m; *R. griersonianum* Balf. et Forr.[1], in west Yunnan, 2100–2700 m; *R. elliottii* Watt[1], in Naga Hills, Manipur, India, 2700 m. These districts, especially from Assam to Yunnan or Szechuan, are the center of the distributions of the elepidote rhododendrons and a large number of the species concentrate in this area.

By contrast, the natural habitat of *R. metternichii* is far from this center. It constitutes one of the marginal species in the elepidotes. Moreover, the distribution pattern of Ponticum series, to which *R. metternichii* belongs, is fairly different from the other series, in that they scatter very sporadically throughout the northern hemisphere. This might indicate the different phylogenic development of Ponticum series from the other series. Therefore, it might be possible to assume that the stoutness of the hybrid seedlings, or the heterosis, might be derived from this geographical as well as phylogenic remoteness between *R. metternichii* and the species which concerned with 'Ruby Hart'. To ascertain this assumption, the similar experiments are being conducted.

Summary

The present investigation was conducted to get a clue to breed the heat resistant garden rhododendrons which will be able to tolerate the severe climate of south-western part of Japan.

The hybrid seedlings derived from a cross 'Ruby Hart' × *R. metternichii* showed much more vigorous growth and much less leaf trouble and plant death than either of the parents in the experimental condition, against which both parents were difficult to tolerate.

The cause of this was attributed to the heterosis, and in the present case the stoutness of hybrid seedlings was assumed to have been derived from the geographical and phylogenic remoteness between *R. metternichii* and the species which concerned with 'Ruby Hart'.

References

1) BOWERS, C. G.: Rhododendrons and azaleas. p. 240, 313, The Macmillan Co., New York (1968)
2) COX, P. E.: Dwarf rhododendrons, p. 130–131, 146–147, B. T. Batsford Ltd., London (1973)
3) WADA, K.: Rhododendrons, in TAMURA, T., SHIBAHATA, Y. and WADA, K. Azaleas, satsukis and rhododendrons (in Japanese). p. 233–234, 343–356, Kodansha Inc., Tokyo (1974)