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SHORT COMMUNICATIONS

On heat treatment of Chrysanthemum morilifolium against Puccinia horiana

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Hellmers (1964) suggested control of *Puccinia horiana* P. Henn. by treating plants at 37 to 40 °C for 20 hours. As little is known about the control of *P. horiana*, the authors decided to do the pilot experiment reported hereunder.

Plants of cv. 'Indianapolis White G 4' were used, each with at least ten green leaves. Plants were inoculated on 13 July, 1966, by spraying a mixer-made suspension of sporulating lesions over the leaves until runoff. After inoculation the plants were placed in an unconditioned greenhouse. The resulting infection was satisfactory.

Plants showing a regular infection were treated in dark climate cabinets at five temperatures ranging from 30 to 52 °C during 8 exposure times ranging from 0 to 48 hours (see Table 2). For each treatment two potted plants were placed in one polythene bag. The effect of different humidities during treatment was eliminated by adding a large piece of wetted cotton wool to each bag before closing the bags. Care was taken to end all treatments at the same moment, 18 days after inoculation.

After treatment the plants and the untreated controls were placed in a greenhouse kept at a temperature of ca. 22 °C. The relative humidity of the air was low in order to prevent re-infection. Leaves were numbered 1 to 10 downwards beginning with the highest leaf measuring 1 cm or more in length. Observations were made at 2, 10 and 24 days after the end of treatment. For each leaf the percentage area covered by sporulating mycelium and by chlorosis and necrosis due to rust and/or treatment was observed. On day 24, notes were taken on the general condition of the plants (Fig. 1).

Table 1 shows the average percentage chlorosis, sporulation, and necrosis of the leaves at days 2 and 10 after treatment at 40 °C. In the untreated control necrosis increases from day 2 to day 10 at the expense of green leaf area. After 4 hours exposure necrosis increases at the cost of sporulation. With longer exposure times necrosis increases at the expense of chlorosis or even of green (but infected?) area. The trend is the same for all temperatures. The sub-total of chlorosis and sporulation can be used to measure the effect of treatment.

Table 2 shows the effect of the various treatments on chlorosis + sporulation. There

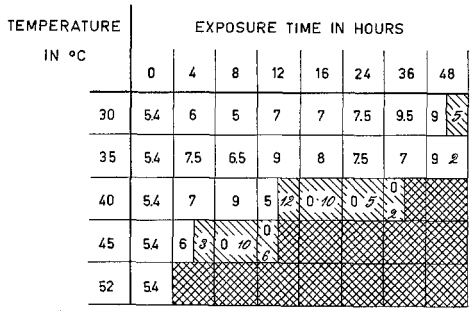

Fig. 1. Plant vigour after various treatments. Number of newly formed leaves per plant as counted on day 24 after the end of treatment. White fields: terminal bud intact; hatched fields: terminal bud killed; cross hatched fields: plants dead. Figures in italics: number of lateral shoots formed.

Fig. 1. Vitaliteit van de planten na behandeling. Aantal nieuw gevormde bladeren, geteld op de 24ste dag na het einde van de behandeling. Blanco velden: eindknop intact; gearceerde velden: eindknop dood; kruiswijs gearceerde velden: planten dood. Cursieve cijfers: aantal gevormde zijscheuten.

Table 1. Percentage of leaf area affected by chlorosis, sporulation, and necrosis after various exposure times at 40 °C. Entries are averages from 2 plants with 10 leaves each, determined 2 and 10 days after the end of treatment. Exposure times of 36 and 48 hours killed the plants.

	Days after treatment	*Exposure time in hours*					
		0	*4*	*8*	*12*	*16*	*24*
Chlorosis	2	7	9	5	6	3	6
	10	5	3	3	3	2	1
Sporulation	2	22	12	2	0	0	0
	10	28	4	1	0	0	0
Sub-total	2	29	21	7	6	3	6
	10	33	7	4	3	2	1
Necrosis	2	1	3	12	11	21	21
	10	17	26	9	18	33	21
Total	2	30	24	19	17	24	27
	10	50	33	13	21	35	22

Tabel 1. Percentage van het bladoppervlak met chlorose, sporulerend mycelium en necrose na diverse behandelingsd uren bij 40 ° C.De getallen zijn gemiddelden van 2 planten met ieder 10 bladeren, bepaald op de 2e en 10e dag na het eind van de behandeling. Bij een behandelingsduur van 36 respectievelijk 48 uur werden de planten gedood.

Table 2. Percentage of leaf area affected by chlorosis and sporulation after various treatments. Entries are averages from 2 plants with 10 leaves each, determined at day 10 after the end of treatment. Death of plants is indicated by †.

Temperature (in °C)	*Exposure time in hours*							
	0	*4*	*8*	*12*	*16*	*24*	*36*	*48*
30	33	25	27	24	15	11	6	1
35	33	24	26	6	3	4	2	0
40	33	7	3	3	2	1	†	†
45	33	2	0	†	†	†	†	†
52	33	†	†	†	†	†	†	†

Tabel 2. Percentage van het bladoppervlak met chlorose en sporulerend mycelium na diverse behandelingen. De getallen zijn gemiddelden van 2 planten met ieder 10 bladeren, bepaald op de 10e dag na het eind van de behandeling. Dode planten zijn aangeduid met †.

is a narrow margin between complete rust suppression and killing of the whole leaf. Best results were obtained from 8 hours at 45 °C and from 48 hours at 35 °C. Good results were obtained when the approximate relation between the exposure time e and the temperature t was: $e = -4t + 188$, within the limits of this experiment ($4 \leqslant e \leqslant 48$ hours, $30 \leqslant t \leqslant 45$ °C).

Plant vigour after treatment was evaluated on day 24. The average number of leaves on the main shoot formed after treatment was counted. Death of terminal buds or whole plants was recorded and the number of newly formed lateral shoots determined (Fig. 1). Treatments giving good or moderate rust control usually killed the terminal buds thus causing deformation of the plants.

The following tentative conclusions are drawn from this pilot experiment:

1. In milder treatments the death of infected tissue proceeds slowly and is completed between days 2 and 10 after treatment (Table 1).
2. All or nearly all of the active rust infections as indicated by chlorosis and/or sporulation disappear in treatments where the relation between exposure time e and temperature t approximates to the formula $e = -4t + 188$ (Table 2).
3. In the exposure time/temperature combinations indicated by the formula the terminal bud usually is killed, but enough lateral buds develop to save the plant (Fig. 1).
4. In slightly milder treatments than those indicated by the formula some rust control is obtained (Table 2), the terminal bud is saved and the development of new leaves is faster than in the untreated control (Fig. 1); total disappearance of the rust, however, cannot be guaranteed.
5. These conclusions roughly confirm those of Hellmers (1964).
6. In view of the technical difficulties involved and of the narrow margin between effective rust control and death of the plants, heat control seems to be indicated only for saving rusted mother plants; heat control under the conditions of the experiment cannot yet be advised for commercial application to commercial potted plants or cuttings.

Samenvatting

Over warmtebehandeling van Chrysanthemum morilifolium tegen Puccinia horiana

Een deel van door *Puccinia horiana* aangetast weefsel van chrysant sterft geleidelijk af na een warmtebehandeling van de planten (Tabel 1). Chlorose en/of sporulatie van de roest verdwijnen geheel of bijna geheel bij een behandeling waarvan het verband tussen de duur der behandeling *(e)* en de temperatuur *(t)* wordt benaderd door de formule $e = 4t + 188$ (Tabel 2). Onder de door deze formule weergegeven omstandigheden worden de eindknoppen van de planten gedood, maar de zijknoppen vormen nieuwe scheuten (Fig. 1).

Bij een doeltreffende bestrijding van de roest is de sterfte onder de planten zo groot, dat een warmtebehandeling van potplanten en stekken niet kan worden geadviseerd. Voor aangetaste moerplanten lijkt deze behandeling evenwel mogelijk.

Reference

Hellmers, E., 1964. Forslag till bekaempelse af japansk chrysanthemumrust. Gartner Tid. 80: 350–352.