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Mature plant resistance of potato against some virus diseases. II. Mature plant resistance and the influence of temperature on the ribosome and RNA content in leaves

J. H. VENEKAMP[1] and A. B. R. BEEMSTER[2]

[1] Centre for Agrobiological Research (CABO), Wageningen
[2] Research Institute for Plant Protection (IPO), Wageningen

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Abstract

Potato plants 'Bintje' were grown in growth chambers; one group of 27 plants at a daily regime of 15 h light and 9 h darkness with corresponding temperatures of 18 C and 12 C, and a second group of 27 potato plants at a daily regime of 15 h light and 9 h darkness with corresponding temperatures of 22 C and 17 C. The plants of both groups were inoculated with potato virus X (PVX) 56 days after planting. Young leaves had a 3-fold higher ribosome and RNA content than ageing leaves. The decrease occurred earlier at 22 C than at 18 C.

Although plants grown at 18 C produced smaller and fewer leaves than those grown at 22 C, the former produced a higher weight of tubers than those at the higher temperature. Although corresponding leaves of both groups showed considerable differences in ribosome and RNA contents, the rate of virus translocation to the tubers was equal in both groups. This can be explained by the different growth pattern.

Additional keyword: potato virus X.

Introduction

Venekamp and Beemster (1979) reported the presence of large amounts of ribosomes and RNA in young leaves of greenhouse-grown potato plants. After a rapid decrease of these contents they remained at a more or less constant level. In those experiments a marked mature plant resistance against potato virus X (PVX) coincided with a rapid decrease in the concentrations of ribosomes and t-RNA in the 15th leaf.

In the present study the ribosome and RNA concentrations in a number of leaves were studied in potato plants grown at two different temperatures. At the same time information was obtained on the rate of translocation of PVX.

Materials and methods

A group of 27 potato plants 'Bintje' was grown in a growth chamber. The daily regime was 15 h light of 15000 lux and 9 h darkness with corresponding temperatures of 18 °C and 12 °C (indicated as 18 °C plants). A second group of 27 potato plants was grown in a growth chamber with a daily regime of 15 h light of 15000 lux and 9 h darkness and corresponding temperatures of 22 °C and 17 °C (indicated as 22 °C plants).

Table 1. Concentrations of ribosomes (R) and RNA in leaves, weights of tubers and percentages of infected tubers of potato plants 'Bintje' of different ages. The plants were grown in growth chambers and the youngest fully expanded leaves were inoculated with PVX 56 days after planting.

Age of plants in days on the date of sampling	Leaf number	Daily period of 15 h light and 18 °C, 9 h darkness and 12 °C				Daily period of 15 h light and 22 °C, 9 h darkness and 17 °C			
		absorbance per ml and per g fresh weight		tuber weight per plant in g	% infected tubers	absorbance per ml and per g fresh weight		tuber weight per plant in g	% infected tubers
		R	RNA			R	RNA		
32	5	0.8	3.6			0.8	6.4		
35		0.4	2.8			0.7	3.8		
39		0.3	1.9			0.5	3.6		
49		0.4	1.8			0.6	2.1		
56		0.6	1.9			0.5	2.1		
60		0.4	1.0			0.1	1.5		
63		0.5	1.0	190	0			134	9
68		0.2	1.0						
70				234	21			201	2
77				252	65			216	66
32	10	10.5	33.7			7.5	23.6		
35		3.7	23.0			2.4	9.0		
39		0.9	9.8						
49		0.7	0.5			2.5	3.6		
53		1.0	0.8			2.1	3.3		
63				190	0	2.2	3.3	134	9
68						0.6	3.0		
70				243	21	0.6	3.2	201	2
77				252	65			216	66
35	15	19.1	40.0			9.6	28.0		
39						1.7	18.0		
49		2.6	25.6			1.1	5.6		
56		2.2	9.6			1.2	3.1		
60		2.3	8.3						
63		2.3	3.6	190	0			134	9
70		1.7	2.4	243	21			201	2
77				252	65			216	66
53	20					6.8	13.2		
56						2.8	11.8		
60						2.2	2.9		
63		22.5	16.3	190	0	2.4	2.5	134	9
68		2.4	6.3			0.7	2.3		
70				243	21			201	2
74		1.1	1.3			0.4	1.7		
77				252	65			216	66
63	25					>10	19.7		
70						1.9	16.0		

Tabel 1. Concentraties van ribosomen (R) en RNA in bladeren, knolgewichten en percentages geïnfecteerde knollen van aardappelplanten 'Bintje' van verschillende leeftijden. Planten geteeld in klimaatkamers en geïnoculeerd met PVX, 56 dagen na het poten.

Fig. 1. The ribosome and RNA contents in leaves of potato plants 'Bintje' of different ages. Plants grown in growth chambers. Data see Table 1. ——— 15 h light, 18 °C; 9 h darkness, 12 °C; --------- 15 h light, 22 °C; 9 h darkness, 17 °C; ..... data missing.

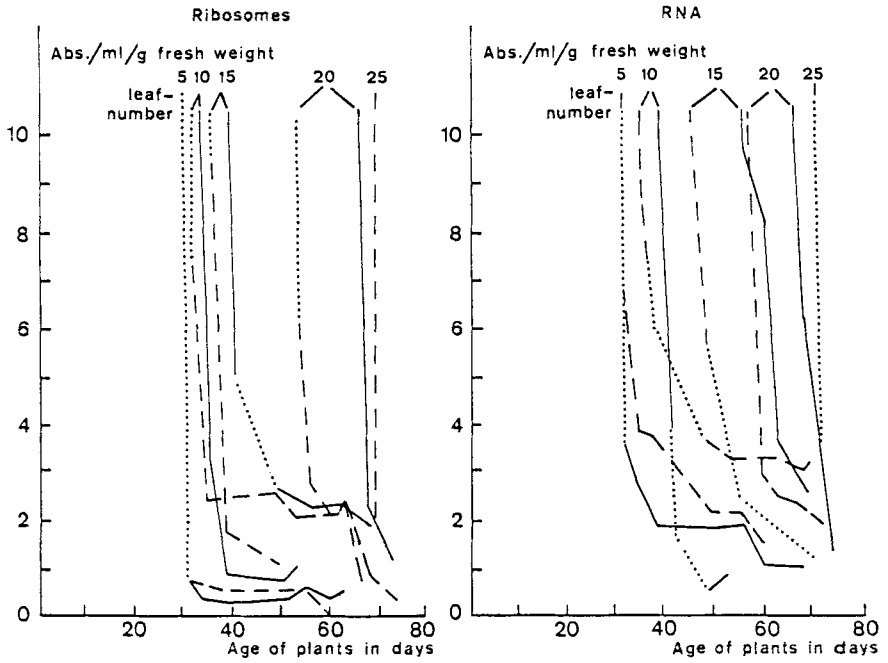

Fig. 1. De gehalten aan ribosomen en RNA in bladeren van aardappelplanten 'Bintje' van verschillende leeftijden. Planten geteeld in klimaatkamers. Gegevens zie Tabel 1. ——— 15 uur licht, 18 °C, 9 uur donker, 12 °C; --------- 15 uur licht, 22 °C, 9 uur donker, 17 °C; ..... gegevens ontbreken.

The youngest completely developed leaf of each plant was inoculated with PVX 56 days after planting. The PVX preparation used was described by Venekamp and Beemster (1979). The 5th, 10th, 15th, 20th and 25th (if present) leaves of three plants of each group were sampled at weekly intervals starting 32 days after planting. Ten grams of each of the leaves mentioned were used to determine the contents of ribosomes and of an RNA fraction with a molecular weight of < 60000 (Venekamp and Beemster, 1979). This fraction is referred as RNA. One, two and three weeks after inoculation the tubers of nine plants of each group were harvested. The weight of the harvested tubers is given in Table 1, together with other results of the experiment. Planting of all tubers resulted in young plants. The extent of tuber infection was determined by inoculation of *Gomphrena globosa* with extracts from these young plants.

Results

The ribosome and RNA contents in young leaves, expressed in absorbances per ml and per gram, measured at 260 nm wavelength, were mostly more than 10. In ageing leaves a rapid decrease of these contents was observed. The ribosome concentration in the 5th

leaf of 32-day-old plants of both groups gave absorbances of less than three (Table 1 and Fig. 1).

Thirty-two days after planting the 10th leaf could be considered as young. The ribosome and RNA contents of this leaf were very high in both groups, however, those of the 22°C plants were lower than those of the 18°C plants. The ribosome and RNA contents of the 15th leaf 35 days after planting were comparable with those of the 10th leaf of the 32-day-old plants. However, the differences between the two groups in the contents of the 15th leaf were about 10 for ribosomes and 12 for RNA. This held for the 20th leaf to a larger extent. Sixty-three days after planting the contents of ribosomes and RNA of the 20th leaf from the 18 °C plants were 22.5 and 16.3, respectively. In the 20th leaf of the 22°C plants these components had contents of 6.8 and 13.2, respectively. Only the 22°C plants produced a 25th leaf. The ribosome content of this leaf decreased very rapidly from more than 10 to 1.9.

The production of the tubers of the 22 C plants was retarded, compared to that of the 18 C plants. The latter yielded 190, 243 and 252 g tubers per plant at the first, second and third harvest, respectively, whereas the 22 C plants yielded 134, 201 and 216 g, respectively.

One week after inoculation with PVX no tubers from the 18 C plants were found to be infected. At that time the percentage of infected tubers from the 22 C plants was 9. Two weeks after inoculation these percentages were 21 and 2, respectively, whereas three weeks after inoculation they were 65 and 66, respectively. In the table the ribosome and RNA contents on sampling days of 63 or later are missing. Then leaves were no more in good condition for an estimation of these contents.

Discussion

The analyses started when the 5th leaf had already passed the stage of rapid decrease in ribosome and RNA contents. Apparently these leaves of both plant groups were about in the same stage of growth at the time of the analyses. The leaves grown at 22 –17 °C, however, showed a tendency of enhanced development, compared to those grown at 18 –12 C. According to Fig. 1, the ribosome content of the 10th leaf from the 22 C plants decreased slightly earlier than that from the 18 C plants. For the 15th leaves this difference was 4–5 days and for the 20th even 12 days. A similar tendency was found for RNA. For these comments it is assumed that the ribosome and RNA concentrations had similar levels in all the leaves at early stages of development.

Considering the results of Venekamp and Beemster (1979), the ribosome and RNA contents of the 15th leaf would indicate the condition of the plants with respect to mature plant resistance. The results of the analyses described here might therefore suggest that the 22°C plants would show mature plant resistance somewhat earlier than the 18°C plants. This would be true if both groups of plants had been inoculated on the same leaf (e.g. the 15th) and if both groups indeed produced the same number of leaves. However, it can be concluded from Table 1 that at 22°C the plants produced a greater number of leaves, which means that, when considering the 15th leaf, this leaf from the 22°C plants reached a mature stage (low ribosome and RNA contents) earlier than that of the 18°C plants. In fact the inoculation was performed on the youngest fully expanded leaf, which means that this was about the 15th leaf of the 18 °C plants and about the 20th leaf of the 22 plants. From the infection rates of the tubers it can be

concluded that both groups showed roughly the same rate of tuber infection. When considering the ribosome and RNA contents of these two kinds of leaves, it is clear that these were about the same. Since the rate of virus multiplication and, later on, virus translocation to tubers have a more or less remote relation to ribosome and RNA-concentration, it could be expected that tuber infection of both groups in this experiment would be equal.

The results suggest an influence of the development of the plant and effects of environmental conditions, e.g. temperature, on the concurrence of ribosome and RNA contents of the 15th leaf and mature plant resistance. It is still premature to propose the use of the youngest fully expanded leaf instead of the 15th leaf.

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Samenvatting

Ouderdomsresistentie van aardappelplanten tegen enkele virusziekten. II. De ouderdomsresistentie en de invloed van de temperatuur op het ribosoom- en RNA-gehalte in bladeren

Een groep van 27 aardappelplanten 'Bintje', werd in een klimaatkamer bij een periode van 15 uur licht en 18 °C en een periode van 9 uur donker en 12 °C geteeld. Een tweede groep van 27 aardappelplanten 'Bintje' werd in een klimaatkamer bij eenzelfde licht- en donkerperiode met temperaturen van 22 °C en 17 °C geteeld. De planten van beide groepen werden 56 dagen na het poten met aardappel X-virus (PVX) geïnoculeerd.

De ribosoom- en RNA-gehalten van de jonge bladeren uitgedrukt als extinctie per ml en per gram vers gewicht, waren meer dan 10. Bij het ouder worden van de bladeren liepen de gehalten zeer snel terug tot minder dan 3; bij 22 °C eerder dan bij 18 °C.

Hoewel bij de 18 °C planten een kleiner aantal bladeren tot ontwikkeling kwam dan bij de 22 °C planten, waren die veel groter en de 18 °C planten leverden dan ook een groter knolgewicht op dan de planten die bij hogere temperatuur waren geteeld. Aan deze verschijnselen werd de mogelijke oorzaak toegeschreven voor het feit dat tussen beide plantengroepen geen verschil in de mate van virustransport van PVX naar de knollen was gevonden.

References

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Addresses

Centrum voor Agrobiologisch Onderzoek (CABO), Bornsesteeg 65, Postbus 14, 6700 AA Wageningen, the Netherlands.
Instituut voor Plantenziektenkundig Onderzoek (IPO), Binnenhaven 12, Postbus 42, 6700 AA Wageningen, the Netherlands.