

Infection pressure of potato virus Y^N

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Bait plant, volunteers.

Abstract

Potato virus Y^N (PVY^N) infection was determined by the tobacco test in Swifterbant (Eastern Flevoland). In plots with beet, wheat and seed potatoes the infection exhibited an identical course. No differences were found either between PVY^N infection in the border and that in the middle of a field planted with ware potatoes, although infection pressure was clearly higher here than in the plot with seed potatoes. A barrier crop of 10 rows of wheat did not decrease the infection pressure of the virus.

From August onwards, the spread of PVY^N in Lienden (Betuwe) was followed. Here virus transmission was found continuously, even until mid-November.

Potato volunteers outside as well as in potato fields are serious infection sources. In 1976 and in 1977 virus spread was detected before the flight of *Myzus persicae*, as determined with yellow Moericke traps. Infection pressure can be measured more efficiently by the tobacco test than by aphid trapping. The effect of rogueing at the time of virus spread should be reconsidered.

If infection pressures in different areas or successive years are to be compared, the tobacco test should be standardized. A proposal to this effect is made.

Introduction

The course of the infection pressure of potato virus Y^N (PVY^N) during the growing period of the potato can be studied very well with tobacco as bait plant (Van Hoof, 1977). In the present investigations we used this method to compare the course of PVY^N infection in seed potatoes with that in the border and in the middle of ware potatoes. Moreover it was tried to obtain information on the influence of potato volunteers in adjacent beet fields and of a barrier crop of wheat on the course of PVY^N infection.

From August until mid-November 1977 the infection pressure of PVY^N was also studied in Lienden (Betuwe) in the centre of the Netherlands.

Materials and methods

In a seed potato growing area plants of *Nicotiana tabacum* cv. White Burley were placed in two farmers fields in Swifterbant (Eastern Flevoland). The tobacco plants were replaced weekly and screened for PVY^N infection as described earlier (Van Hoof, 1977). On one farm 100 tobacco plants, planted in pots, were placed in the middle of a field of 8 ha ware potatoes (cv. Bintje), another 100 plants in the south west border of the same field. They were placed in three rows of 33, 34 and 33 plants, respectively. Virus infection was determined separately for each row. A third lot of 100 to-

bacco plants was placed in a beet field at a distance of 20 m from the border. The fourth lot, also 100 plants, was placed in a wheat field 3 m from the border in such a way that they were separated by 10 rows of wheat plants from an adjacent tulip field. All plants in the wheat and beet fields were grouped in 2 or 3 rows.

The course of infection of PVY^N in the ware potato field was also studied by testing 100 potato stem tops (collected at random) on A6 leaves every 4 weeks starting on 26 May. An impression of the final infection of the potatoes was obtained by testing the plants grown from 100 tubers (collected at random from the yield) on A6 leaves.

On the second farm the tobacco plants were placed in a field of 12 ha seed potatoes (cv. Bintje), located 6 km from the first farm. From the strip of land where the test plants stood, all volunteers were removed from the beginning. Outside this strip the volunteers were removed only in the normal course of crop care. All sprayings deemed necessary by the farmer were done.

The initial infection of the seed potato field was determined by collecting at random 500 stems on 26 May and testing them on A6 leaves. The final infection was determined by testing in the same way the plants grown from more than 2000 tubers collected just before harvesting.

To study the infection pressure for a longer period, 50 PVY^N infected potato tubers (cv. Gineke) were planted in one row in a field in Lienden (Betuwe) on 1 August 1977. This row of infector plants was bounded on both sides by 50 tobacco plants in the period between 9 August and 15 November. These tobacco plants were replaced weekly and treated as described previously (Van Hoof, 1977).

For a good understanding it must be emphasized that volunteers of potato in field crops and therefore also in potato crops were rather abundant in the area where the trials were performed.

Results

The results obtained at Swifterbant are presented in Table 1. To compare them with the results of the 1976 trials on the same farm (Van Hoof, 1977), the latter are also included in this table. Extra infector plants were placed around the test plants in 1976, but not in 1977. The wave of infection in 1977 started three weeks later than in 1976, but set in vigorously. By the second week of June, the tobacco plants in the ware potato field were already infected for 98%. In the second half of June infection of the test plants decreased strongly due to cold weather, which reduced aphid motility. During the rest of the season the test plants were infected for almost 100% with PVY^N.

It is of interest to compare the data of the yellow Moericke traps in the Swifterbant area with our data obtained with bait plants. In 1976 it lasted till 3 July before two *Myzus persicae* were trapped daily and in 1977 this number was never reached.

The infection of the potato stem tops from the ware potato field was 11% on 26 May, 16% on 23 June, 52% on 22 July and 44% on 18 August. The crop was harvested in the last week of September. The check on 100 of the harvested tubers in January 1978 yielded a final infection of 94%.

The initial infection of the seed potatoes was 3.6%. The infection at the end of the growing season was 15.3%.

The results of the Lienden trial are presented in Table 2.

Table 1. Number of tobacco plants (cv. White Burley) infected with PVY^N per group of 100 plants (Swifterbant).

Period	1976		1977						
	ware potatoes	beet	wheat	seed potatoes	ware potatoes				
					border			middle	
28-04 to 05-05	0	0	0	1				0	0
05-05 to 12-05	0	0	0	0				0	0
12-05 to 19-05	5	0	0	0				0	0
19-05 to 26-05	17	0	- ¹	0				- ¹	- ¹
26-05 to 02-06	25	1	0	2	(0	0	1) ²	1	0
02-06 to 09-06	82	6	5	11	(11	15	15)	41	46
09-06 to 16-06	100	54	66	69	(33	32	33)	98	99
16-06 to 23-06	98	1	1	2	(5	2	4)	11	8
23-06 to 30-06	98	3	6	4	(16	9	24)	49	61
30-06 to 07-07	100	28	27	31	(28	34	30)	92	97
07-07 to 14-07	100	45	43	67	(33	34	33)	100	100
14-07 to 21-07	100	5	17	-	(28	34	33)	95	99
21-07 to 28-07	80	20	55	-	(33	34	33)	100	100
28-07 to 04-08	44	29	35	-	(33	34	33)	100	100
04-08 to 11-08	73	18	25	-	(28	33	32)	93	100
11-08 to 18-08	30	32	28	-	(33	34	31)	98	100
18-08 to 25-08	8								

¹The tobacco plants were unintentionally killed with a herbicide.

²The tobacco plants in the border of the potato field were planted in three rows of 33, 34 and 33 plants. They were assessed separately, the last of these columns represents the row of plants next to the potato crop.

Tabel 1. Het aantal tabakspplanten (cv. White Burley), dat per groep van 100 planten, met PVY^N werd besmet (Swifterbant).

Table 2. Number of tobacco plants (cv. White Burley) infected with PVY^N per group of 100 plants (Lienden).

Period 1977	Plants infected	Period 1977	Plants infected
09-08 to 16-08	40	27-09 to 04-10	5
16-08 to 23-08	30	04-10 to 11-10	6
23-08 to 30-08	52	11-10 to 18-10	11
30-08 to 06-09	31	18-10 to 25-10	25
06-09 to 13-09	22	25-10 to 01-11	14
13-09 to 20-09	16	01-11 to 08-11	5
20-09 to 27-09	12	08-11 to 15-11	3

Tabel 2. Het aantal tabakspplanten (cv. White Burley), dat per groep van 100 planten, met PVY^N werd besmet (Lienden).

Fig. 1. PVY^N infection of potato stem tops (●—●) and of tobacco test plants (○—○) in a field of ware potatoes. ⊙ : tuber infection at the time of harvesting, assessed in January 1978.

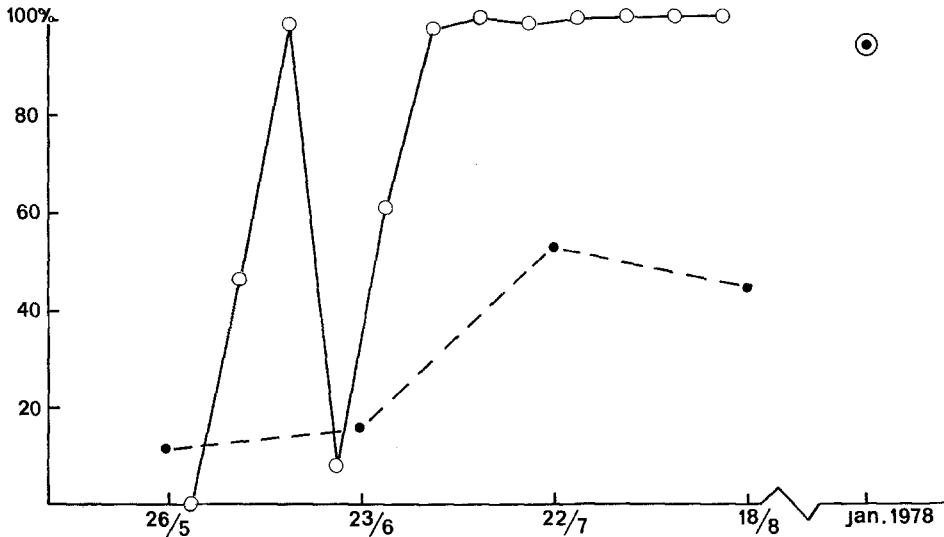


Fig. 1. PVY^N-infectie van aardappelstengeltoppen (●—●) en van tabaksplanten (○—○) in een veld consumptieaardappelen. ⊙ : knolinfectie op tijdstip van rooien, getoest in januari 1978.

Discussion

In the period from the end of April to the beginning of May 1977, only one of the 500 tobacco plants, used in the Swifterbant trials became diseased (Table 1). The potatoes had not yet emerged because planting was late owing to the rainy weather in April. This infestation must have originated from outside the field and have been caused by aphids from the spring flight. This slight infestation may not seem important, but indeed is, as it may create primarily diseased plants, which in turn can act as virus sources early in the growing season.

The test plants placed in three rows in the border of the ware potato field showed a trend of infection similar to that in the middle of the field. They were infected at the same time and infection pressures were equal. Between the rows of tobacco plants no significant differences were found. Only in the week from 23 to 30 June the row next to the potato field was clearly more heavily infected than the other two.

The course of infection of the test plants in the beet, wheat and seed potato fields showed no significant differences. This implies that a barrier of 10 rows of wheat did not decrease the infection pressure of PVY^N.

The conclusion is justified that potato volunteers in both beet and wheat have acted as infection sources.

A cold spell from 16 to 30 June following a warm period from 9 to 15 June resulted in infection of a low number of the tobacco plants in the beet, wheat and the seed potato fields. The influence of the low temperature was restricted to the week of 16 to 23 June in the ware potato field. From 23 to 30 June quite a high number of the test plants became infected, despite reduced aphid motility. This indicates virus spread

over very short distances in this field.

The infection established by testing stem tops of potato plants showed a sharp increase between 23 June and 22 July, as in shown in Fig. 1 in which the data from Table 1 are combined with the data on potato stem top infection of the same ware potato field. The eventual infection of the tubers was 94%. We did not extensively test the potato stem tops for the presence of PVY^N, because probably only a rough indication of what happens in the field can be obtained in this manner. However, more data about the period from 23 June to 22 July would have been most welcome. Probably the potato foliage, but not yet the stem tops became severely infected in the period from 2 to 15 June and acted as a ubiquitous virus source for infection in the week from 23 to 30 June. The increase in virus spread in the period from 23 to 30 June (Table 1) probably did not contribute to the infection of the stem tops because the plants were already aged and consequently the rate of virus multiplication must have been low in the leaves infected with PVY^N by the aphids (Beemster, 1961). Stem top infection was somewhat lower on 18 August. Then the foliage was in a bad state as a result of fungus infestation and ageing, which made virus detection probably less reliable.

Transmission of PVY^N in the Lienden trial took place during an exceptionally long period in 1977 (Table 2). The percentages of infected tobacco plants in this area were often low compared with those in Swifterbant and never reached hundred. Lienden is agriculturally an area in which aphid populations are much higher in July than in Swifterbant in the same month, but then decrease rapidly through parasitization (Schepers, 1964). However, it is surprising that PVY^N was still transmitted considerably until in November even though the infection source was practically extinct and the tobacco plants suffered severely from heavy winds during the week in the field. Very large flights of *Rhopalosiphum padi* occurred from mid-September till the end of October (Van Harten, personal communication). Although this aphid seems to be an inefficient vector of PVY^N, it may have been responsible for the relatively high degree of infection of the test plants in the Lienden experiment.

The question arises whether results obtained with the tobacco test plant method can be used to explain the differences in tuber infection experienced by the producers of seed potatoes. In 1976 the seed potato industry was faced with a heavy infestation of PVY^N, whereas in 1977 the situation was generally somewhat better. In our experiments in ware potatoes a striking difference was found between the infection rates of the test plants during the first periods of these years: viz. 5, 17 and 25%, respectively, in the last three weeks of May 1976, whereas the corresponding percentages for 1977 were 0, 0 and 1. Part of these differences may have to be attributed to the fact that in 1976 infector plants (potatoes) were planted near the site where tobacco was placed. In 1977 no infector plants were planted, thus then volunteer potato plants, present in abundance in near-by fields were responsible for the ultimate rate of the infection pressure. Seed potatoes can be infected from outside through the spring flight of aphids. It is very likely, however, that the most important way of virus spread starts both from diseased plants (secondarily infected plants) and infected volunteer plants present in the crop itself. The spread of PVY^N in 1976 as well as in 1977 took place when removal of secondarily infected plants had not yet started or was just under way. One may ask whether it is better to omit rogueing when aphids are present, as by disturbing the aphids, virus spread can involuntarily be promoted. The use of

mineral oils with the aim to reduce transmission of PVY^N (Schepers et al., 1977) may be a better alternative.

The method of using tobacco as a bait plant to obtain information concerning the rate of tuber infection of seed potatoes to be expected seems attractive. Till now the rate of bait plant infection and tuber infection at the time of harvesting could not be correlated by lack of sufficient data. However, if infection pressures between regions and years have to be compared, the method must be standardized. Tobacco plants should be placed in a potato field with a known, rather low percentage of initial infection (3.6% proved to be satisfactory in our experiments). When the initial infection is high, the test plants will be infected too quickly by which the differences between objects would be obliterated.

The presence of potato fields with a constant initial infection over the years cannot be realized easily, however. Tobacco could be placed in a beet field in which potato volunteers are present as infection sources. As the state of health of the volunteers is often typical for a certain area, the volunteers should not be removed and normal agricultural practice should be performed as usual. In the beet fields three rows of beets, each of 15 m, should be replaced by tobacco plants. Thus mechanical weeding remains possible. During severe winters potato tubers will be killed and no volunteers will appear. After such winters it will be advisable to plant a number of infected potato tubers in the beet field, which should not be removed during the test period. On either side of the test strip at a distance of 5 m five PVY^N-diseased potatoes can be planted.

As can be concluded from the data in Table 1, only small differences were found between the three rows of 33, 34 and 33 plants. Therefore, it may be possible to use a number of plants smaller than 100 when many tests have to be carried out.

Samenvatting

De infectiedruk van het aardappel-Y^N-virus

In Swifterbant (Oostelijk Flevoland) werd de infectie met het aardappel-Y^N-virus (PVY^N) bepaald met behulp van de tabakstoests. In percelen met bieten, tarwe en pootaardappelen bleek de infectie hetzelfde verloop te hebben. Tussen het infectieverloop van PVY^N in de rand en in het midden van een veld consumptieaardappelen werd eveneens geen verschil gevonden. Wel was de infectiedruk hier duidelijk hoger dan in het pootgoedperceel. Een 'barrier crop' van 10 rijen tarwe verminderde de infectiedruk niet.

De volgende conclusies kunnen worden getrokken. Aardappelopslag buiten en in aardappelvelden vormt een zeer belangrijke infectiebron. Zowel in 1976 als in 1977 vond de virusverspreiding plaats vóór de vlucht van *Myzus persicae* begon, zoals deze werd bepaald met behulp van de gele Moericke vangbakken. Het effect van opzuiveren ten tijde van de virusverspreiding dient aan een nader onderzoek te worden onderworpen. De infectiedruk kan met de tabakstoets op meer directe wijze worden vastgesteld dan met bladluisvangsten mogelijk is.

Wil men overgaan tot het vergelijken van de infectiedruk in verschillende gebieden of in verschillende jaren, dan dient de tabakstoets te worden gestandaardiseerd. Een voorstel hiertoe wordt gedaan.

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References

- Beemster, A. B. R., 1961. Translocation of leafroll and virus Y in the potato. Proc. 4th Conf. Potato Virus Dis., Braunschweig 1960 : 60-67.
- Hoof, H. A. van, 1977. Determination of the infection pressure of potato virus Y^N. Neth. J. PL. Path. 83 : 123-127.
- Schepers, A., Bus, C. B., Bokx, J. A. de & Cuperus, C., 1977. De verspreiding van Y^N-virus in aardappelen. Landbouwk. Tijdschr. 89 : 123-128.
- Schepers, A., 1964. De teelt van pootgoed in het najaar. Pootaardappelen als stoppelgewas. Kali 62 : 59-66.

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