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The viscosity of mineral oils, in relation to their ability to inhibit the transmission of stylet-borne viruses

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Abstract

Thirteen fractions were obtained by distillation of the mineral oil Bayol 50 (ESSO 2214) and these were tested for their ability to inhibit the transmission of potato virus Y to red pepper. The less viscous fractions < 8 cSt at 37°C (52 SUS) were shown to be less active, the more viscous fractions were more active than Bayo150 with a viscosity of 8 cSt at 37°C. Sunoco 7E, a mineral oil with a viscosity of 14.2 cSt at 37°C (74 SUS) was shown to be significantly more active than Bayol 50. The difference in emulgator had no influence on these results. We, therefore, recommend to choose mineral oils with a viscosity of at least 12 cSt at 37°C (= 66 SUS) for future work on the inhibition of the transmission of stylet-borne viruses.

Introduction

Since Bradley (1962) and Bradley et al. (1963) reported that mineral oil inhibits the transmission of potato virus Y and other styletborne viruses, much research has been carried out to elucidate the mechanism of this phenomenon. Among various types studied the paraffinic mineral oils showed the strongest inhibition of virus transmission, combined with the lowest phytotoxicity; therefore, most of the work has been done with this type of oil which was already commonly used in agriculture for other purposes. Detailed studies on the relation between the physico-chemical properties of mineral oils and their virus transmission inhibiting properties are not known to us, although Vanderveken (1968) suggested already that the viscosity might be of importance. Wyman (1971) reports that a low viscosity (45v = 6 cSt)[1]) mineral oil was more effective than three oils with higher viscosity (80v, 140v and 310v = 16, 30 and 67 cSt at 37°C) in the greenhouse against beet mosaic virus. In the field, however, the 45v oil proved to be ineffective against beet mosaic virus. The three other oils reduced the virus incidence in the field significantly.

[1]). Wyman did not specify the unit in which the viscosity had been measured. Therefore, we assume that the viscosity was expressed in Saybold Universal Sec. (SUS), the unit normally used in the USA.
cSt: the kinematic viscosity in centi-Stokes, 10^{-6}, m^2 /sec., at 37°C.

In a first attempt to obtain a better insight into the relation between the physico-chemical properties and the virus inhibiting properties of paraffinic mineral oils, we distilled Bayol 50 and tested the fractions to see if we could determine any difference in activity. Unfortunately, after testing, not enough material was left of some fractions to determine the viscosity, but nevertheless, we consider the results obtained as sufficiently interesting to be described hereafter.

Table 1. The ability of different fractions of Bayol 50 to inhibit the aphid transmission of potato virus Y.

Legend:
A. Fraction No. **B**. Distillation temperature (°C). **C**. Distillation pressure (mm Hg)
D. Viscosity in cSt at 37°C. **E**. Viscosoty in SUS
F. Number of diseased plants of 100 test plants at the spray concentration of 0.25 and 0.75% and 50 test plants at 2 %:

A	**B**	**C**	**D**	**E**	**F**	**F**	**F**
					0.25%	**0.75%**	**2%**
1	< 1001	0.4-0.45			76	68	-
2	102-105	0.4-0.45	6	45	71	73	29
3	106-110	0.4-0.45			79	62	22a
4	110-114	0.4-0.45			67	64	6a
5	111-115	0.3	6.1	46	73	60	13a
6	115-119	0.3			82	53b	7a
7	120-124	0.3	7.5	50	79	52b	10a
8	124-128	0.3			68	44a	6a
9	124-131	0.35	8.4	53	63	20a	6a
10	131-135	0.35			41a	33a	0a
11	135-140	0.35			49a	25a	1a
12	141-145	0.35	11.1	63	48a	14a	0a
13	rest		18.7	92	32a	20a	2a
Bayol 50			8	52	67	34a	5a
Sunoco 7E			14.2	74	31a	20a	4a
Check					79	78	44

a/b: numerals flanked by the letters a and b are significantly different from the check at the 1% and 5% levels (X test).
\- = no data available

Tabel 1. Het vermogen van verschillende.fracties van Bayol 50 de bladluisoverdracht van aardappelvirus Y te verhinderen.

Materials and methods

Bayol 50 (= ESSO 2214, viscosity: 8 cSt at 37°C or 52 Saybold Universal Sec. - SUS) a paraffinic mineral oil, was distilled in 13 fractions. The viscosity of a number of these fractions was measured and the virus inhibiting activity of each fraction was tested at three different concentrations (Table 1). To obtain a stable emulsion, Bayol 50 and its fractions were mixed with l0%. emulgator Emulsogen M before preparing the water emulsion at the different concentrations. 25 ml of each emulsion were sprayed on 25 test plants. This procedure was repeated two or four times (50 or 100 plants per replicate). The test plants were red peppers (*Capsicum annuum* cv California Wonder) with at least two fullgrown normal leaves. The next day each test plant was inoculated with a normal strain of potato virus Y with the aid of two aphids *(Myzus persicae)* which had previously fasted for 1-2 h. The acquisition period on oil free red peppers was 2-5 min and the inoculation period 2-5 h, after which the aphids were killed with an insecticide. The test plants were incubated in a greenhouse at 20-24°C, about 50% relative humidity and a light period of at least 16 h. Symptoms could be read two weeks after inoculation.

Results and discussion

It can be concluded from the results in Table 1 that the heaviest fractions (No 10- 13) of Bayol 50 have the best virus transmission inhibiting activity. The lower the viscosity, the less activity was found. This is most evident at the spray concentrations of 0.25 and 0.75%. The four heaviest fractions are slightly more active than Bayol 50 itself. Thus, Bayol 50 is a mixture of more or less active and even inactive components. From Table 1 can also be concluded that a more viscous oil, Sunoco 7E (Sun Oil Company), with its own emulgator, is as active as the best of the Bayol 50 fractions, No 13. Table 2 demonstrates in a comparative test that the better performance of Sunoco 7E over Bayol 50 does not depend on the emulgator but on the properties of the oil itself.

Table 2. A comparison of the virus transmission inhibiting properties of Bayol 50 and Sunoco 7 N oil, each containing 10% ofthe emulgator Ernulsogen M and Sunoco 7 E oil, containing 1.2% surfactant of its own.

Oils	Number of plants diseased of 100 plants inoculated: Spray concentration,	
Conc.	0.25%	0.75%
Bayol 50	44a	30a
Sunoco 7 N	19 b	18 a
Sunoco 7 E	19 b	18 a
Check	62 a	65 b

a, b: Nurnerals flanked by the same letter are not significantly different.

Tabel 2. Resultaten van een vergelijkende proef ter bepaling van het virusoverdracht verhinderende vermogen van Bayol 50 en Sunoco 7 N met dezelfde emulgator, 10% Ernulsogen M, en Sunoco 7 E met 1,2% eigen emulgator.

The contradictory results of Wyman (1971) of his greenhouse and his field experiments with the 45v oil must be attributed to a random good result with this low viscosity oil which he sprayed in the greenhouse as a 2% emulsion on only 50 plants per replicate. We consider that 50 plants per replicate are too few to demonstrate differences in activity of mineral oils when there are only slight differences in viscosity. 100 plants are an absolute minimum for this purpose since this larger number tends to smooth the fluctuations in the biological results. Dutrecq and Vanderveken (1969) confirm Bradley's (1963) observations that only 3 $\mu g/cm^2$ leaf of mineral oil is needed to obtain about 60% inhibition of the transmission of potato virus Y, while 7 $\mu g/ cm^2$ leaf of mineral oil was required to obtain about 80% inhibition of the transmission of beet yellows virus. They attribute this difference in results to the difference in persistence of the viruses used. However, it can now also be explained by the difference in viscosity of the mineral oils that were used: a 125-135v oil (= 27.5 cSt at 37'C) by Bradley (1963) and ESSO 2214 (=Bayol 50) with a viscosity of 8 cSt at 37 °C by the two other authors

Summarizing our results, we recommend, therefore, to choose mineral oils viscosity of at least

12 cSt at 37°C (= 66 SUS) for future work on the inhibition of the transmission of stylet-borne viruses.

Samenvatting

De viscositeit van minerale olies als belangrijke eigenschap met betrekking tot de verhindering van de overdracht van noppersistente virussen

Door destillatie van de minerale olie Bayol 50 (ESSO 2214) werden 13 fracties verkregen die getoetst werden op hun vermogen de overdracht van aardappelvirus Y naar paprika te verhinderen. De minder viskeuze fracties, < 8 cSt bij 37'C (52 SUS), bleken minder, de hoger viskeuze fracties meer activiteit te bezitten dan Bayol 50 zelf. Sunoco 7E, een minerale olie met een viscositeit van 14,2 cSt bij 37'C (74 SUS) bleek significant actiever dan Bayol 50 met een viscositeit van 8 cSt bi 37'C (52 SUS). Een verschil in emulgator had geen invloed op deze resultaten. Op grond van deze gegevens is het aan te bevelen geen minerale olie te gebruiken met een viscositeit lager dan 12 cSt bij 37'C (66 SUS) indien men de overdracht van een nonpersistent virus zo effectief mogelijk wenst te verhinderen.

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