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Rearing methods for studying the effect of the physiological condition of the host plant on the population development of *Panonychus ulmi* (Koch)

Within the frame of the harmonizing control of pests in apple orchards, we are looking for other ways of control than the purely chemical one in order to achieve an effective control of the fruit-tree red spider mite (DE FLUITER, 1962).

We are trying to influence the population-development of the red spider mite negatively by inducing a chemical transformation of the feeding substrate of the mite viz. the apple-leaf.

Miss POST (1962) showed that in field experiments in the Netherlands the population density of the fruit-tree red spider mite in well manured orchards was much greater than in neglected orchards.

She found a positive correlation between the Nitrogen content of the leaves and the population density of the fruit-tree red spider mite. These observations suggest that the population density of the fruit-tree red spider mite is affected by the Nitrogen-content of the apple-leaf which in itself is affected by the Nitrogen-manuring of the orchard.

This problem is now approached in laboratory experiments.

The effect of the nutrition of the host plant on the population development of various insects and mites has been studied in laboratory and field experiments by many research workers. However, the results of their investigations are rather contradictory (tab. I).

This may be explained by assuming that an increase of a certain element in the leaf on the one hand increases the resistance of the plant and on the other hand increases the population development of the phytophagous organism.

Changes in the environmental conditions of the experiments determine which of both effects prevails. This might explain the fact that these experiments are so hard to reproduce. Many authors don't give an exact description of the conditions under which they made

Boll. Zool. agr. Bachic., s. II, v. 7, 1965.
(Atti del 5° Simposio europeo d'Acarologia, Milano, 23-25.IX.1965)

TABLE I. - *Effect of fertilizers on the population development of some phytophagous mites. After data from literature.*

Plant	Mite species	Results with								Author	Year
		+N	—N	+P	—P	+K	—K	+Ca	—Ca		
Pyrus malus	*Metatetranychus ulmi*	+*								L. M. BREUKEL et al.	1959
Pyrus malus	*Metatetranychus ulmi*		+*							P. J. CHAPMAN et al.	1952
Phaseolus vulgaris . .	*Tetranychus bimaculatus*	+*	+		+		+			R. FRITZSCHE et al.	1957
Glycine hispida . . .	*Tetranychus atlanticus*	+		●						W. N. CANNON	1964
Persicae vulgaris . . .	*Metatetranychus ulmi*	+*		+*						F. CHABOUSSOU	1960
Phaseolus-persica . . .	*Tetranychus bimaculatus*	+								R. GARMAN et al.	1949
Phaseolus lunatus . .	*Tetranychus bimaculatus*	+				—				T. J. HENNEBERRY et al.	1957
Phaseolus lunatus . .	*Tetranychus bimaculatus*	+*								T. J. HENNEBERRY	1962
Phaseolus lunatus . .	*Tetranychus bimaculatus*	+*		+*		+*				T. J. HENNEBERRY	1962
Phaseolus lunatus . .	*Tetranychus bimaculatus*	+*		+*						T. J. HENNEBERRY	1963
Phaseolus lunatus . .	*Tetranychus bimaculatus*	+*								T. J. HENNEBERRY et al.	1964
Pyrus malus	*Metatetranychus ulmi*	●*		○*		○*		○*		E. O. HAMSTEAD	1957
Pyrus malus	*Tetranychus bimaculatus*	+*		○*		○*		○*		E. O. HAMSTEAD	1957
Pyrus malus	*Metatetranychus ulmi*	+								HUKOSIMA. S	1958
Pyrus malus	*Tetranychus bimaculatus*		+							HUKOSIMA. S	1958
Pyrus malus	*Metatetranychus ulmi*		+							H. G. H. KEARNS	1940
Cucumis spec.	*Tetranychus bimaculatus*	+				+				E. J. LEROUX	1954
Cucumis spec.	*Tetranychus bimaculatus*							—	+	E. J. LEROUX	1959
Pyrus malus	*Metatetranychus ulmi*	●*	○*							F. T. LORD et al.	1961
Solanum lycop., Cucumis	*Metatetranychus ulmi*			+		+				D. MEYAARD	1956
Phaseolus lunatus . .	*Bryobia praetiosa*	+*	—*	+*			+*			O. N. MORRIS	1961
Pyrus malus	*Metatetranychus ulmi*	+								A. POST	1958
Pyrus malus	*Metatetranychus ulmi*	+*								A. POST	1962
Solanum lycop., Cucumis	*Tetranychus bimaculatus*	—*	+*	—		+		●	+	R. G. RODRIGUEZ	1951
Solanum lycop., Cucumis	*Tetranychus bimaculatus*	—		+						J. G. RODRIGUEZ et al.	1952
Pyrus malus	*Metatetranychus ulmi*	●*		●*						J. G. RODRIGUEZ	1958
Pyrus malus	*Tetranychus bimaculatus*	+*		—*	+*					J. G. RODRIGUEZ	1958
Phaseolus lunatus . .	*Tetranychus bimaculatus*	—*		—*				—*		T. F. WATSON	1964

\+ Strong reproduction. — Slow reproduction. ⊙ Without influence on reproduction. ● Some reproduction - not significant. * Results with leaf analysis.

their experiments and very small variations in these conditions may tip the balance to the other side. Besides the interrelations among the ions in the feeding-solution or the soil may give rise to quite unexpected results.

When studying the relations between a phytophagous pest and its host plant, the interpretation of data concerning this interaction is extremely difficult because of the fact that two quite different organisms are involved seperately and in combination.

To know more about the effect of the concentration of leaf-minerals on the development of spider mites, we are growing one-year old apple rootstocks, E. M. 4, in a gravel culture on a feeding solution. At the moment our experiments include six Nitrogen levels. The gravel-culture method we apply was developed by STEINER (1961) at Naaldwijk-Holland.

In our feeding solutions the sum of the anion and kathion-concentration, the osmotic pressure and the pH is kept equal for all solutions. Besides the feeding solution is constantly saturated with molecular oxygen with the aid of a special apparatus. This is of great importance as regards the uptake of ions by the roots.

Other experiments showed that in sand cultures there was no sufficient uptake of minerals owing to lack of oxygen (fig. 1).

By varying the composition of the feeding solution we try to induce differences in the Nitrogen-concentration of the leaves.

The mites were reared on these leaves in little plastic cages. Leaf-analysis must be carried out.

We determine the total amount of Nitrogen in the leaf by means of the « Kjeldahl-method ». Determinations of the amino-acids and reducing sugars in the leaf by means of thin-layer-chromatography, will be done in the future.

In connection with investigations on the influence of specific compounds in the leaf on the feeding-behaviour of phytophagous mites, it is of great importance to be able to rear them on an artificial diet.

FRITZSCHE (1960) and RODRIGUEZ (1963) made investigations in this field on *Tetranychus urticae* (syn. *T. telarius*).

They could keep this mite alive for some weeks on an artificial medium, however, they did not succeed in breeding the mite from egg to egg.

In our experiments we could keep adults of *T. urticae* alive for fourteen days on a very complex diet. However, the egg-production

on the artificial medium was lower than on the natural feeding substrate.

Fig. 1 - Equipment of gravelculture for growing apple-rootstocks.

The first problem was to find a suitable membrane through which the mites could take up liquid food.

By using a thin membrane of collodion or parafilm we got reasonable results but afterwards we got much better results by using the dried inner epidermis of an onion-bulb. Even the larvae are capable to take up food through this one cell-layer-thick membrane.

The limiting factor for the development of the spider mites is now the composition of a feeding solution which has suitable nutritional and gustatory properties.

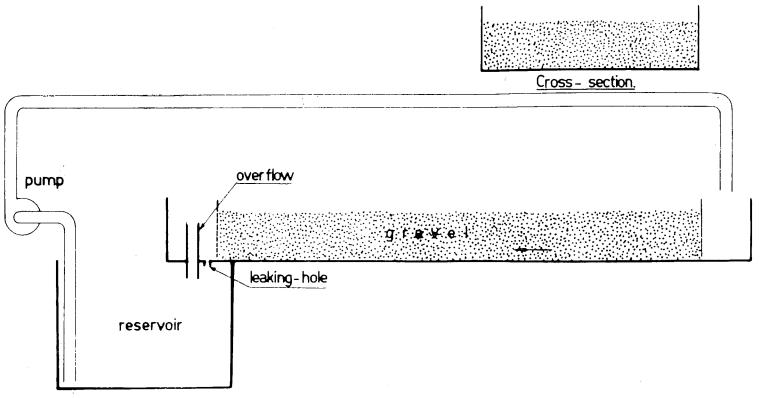

Fig. 2 - Dutch system for gravelculture.

As *P. ulmi* reproduces best under rather humid conditions (about 80 % R. H. is very favourable), we constructed a little climate-chamber for laboratory experiments.

When phytophagous mites can be reared on an artificial diet, quite a new field of research will be accessible. Then the influence of various chemical substances on the metabolism of phytophagous mites can be tested and the research on the feeding-physiology of mites can be started.

We hope theat this will be realised in a not too far distant future.

SUMMARY

To study the relationships between a phytophagous pest and its host plant, the fruit tree red spider mite is reared on leaves of one year old apple rootstocks (E.M. 4) growing in a gravel-culture on feeding solutions with various nitrogen levels. The difficulties met in these experiments are discussed.

Also some data concerning the rearing of *Tetranychus urticae* on an artificial diet are given.

RIASSUNTO

Per studiare le affinità tra fitofago e pianta ospite, l'A. ha allevato il *Panonychus ulmi* su foglie di Melo (porta-innesto E.M. 4). Le piante, di un anno di età, erano coltivate su ghiaia e concimate con soluzioni a differente tenore di azoto.

L'A. illustra le difficoltà incontrate nel corso degli esperimenti e fornisce alcuni dati relativi all'allevamento del *Tetranychus urticae* con diete artificiali.

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DISCUSSION

BOCZEK: I have found that some antimicrobial agents inhibit the development of some mites. Could you confirm that?

STORMS: I use K-sorbate and nipagine as antimicrobials in the artificial diet. I have not yet found a strong inhibition of the devolpment of phytophagous mites due to these antimicrobials.

DE PIETRI-TONELLI: Can you tell us something more about the membranes you used for the artificial rearing of mites?

STORMS: Well instead of collodium I now have good results with Formvar membranes but this material is very difficult to obtain in the Netherlands.

KUCHLEIN: In order to compare the effects on the spider mites you used as a test the « egg-production ». Did you use the day-specific egg-production or the total fecundity of the female.

STORMS: The total egg-production per female.

MELTZER: 1) Did you succeed in rearing the mites from the egg to the the adult stage on an artificial diet?

2) Is the breeding medium which you used completely artificial? I mean whether you made use of plant juices or not.

3) If you got eggs from females on the artificial diet, did they hatch and did the larvae develop?

4) How do you prevent powdery mildew infection in your culture of *Panonychus ulmi*?

STORMS: 1) No; I hope this will be possible in the future.

2) Yes, it is completely artificial but perhaps I have to switch over to a semi-artificial diet.

3) The eggs hatched on the membranes but the larvae did not moult.
4) The rootstock E.M.4. is not very susceptible to the powdery mildew. Besides the warehouse in question has a closed air circulation.

DE PIETRI-TONELLI: Which is the reason the larvae of *T. urticae* do not develop on your artificial rearing system?

STORMS: Perhaps there is a lack of a special compound in the diet necessary for the moulting process. The correct composition of the artificial diet is a very complex matter.

VANWETSWINKEL: Have you done any experiments on the breeding of *P. ulmi* K. on artificial food?

STORMS: Yes, I did, but it is much more difficult to breed *P. ulmi* on an artificial diet because *P. ulmi* has more feeding requirements than *T. urticae*.