

Development of *Myzus persicae* on a partially resistant and on a susceptible genotype of lettuce (*Lactuca sativa*) in relation to plant age

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Abstract

The relationship between lettuce (*Lactuca sativa*) and *Myzus persicae* is influenced by internal and external factors. For the improvement of screening methods and the evaluation of the resistances found, a better knowledge of these factors is wanted.

In five experiments the influence of plant age on resistance level was investigated for a partially resistant and a susceptible cultivar. Criteria for resistance were: remaining percentage of aphids (RPA), aphid developmental rate, insect biomass, and larvae production.

It appeared that the aphids developed faster and grew better on older plants compared with younger plants, resulting in a decrease of overall level of resistance. The absolute differences between the susceptible and the resistant genotype for parameters such as biomass increased if plants were older and aphids were allowed to utilize all parts of the plant. It is concluded that with older plants (plant age e.g. 30–40 days) a better discriminative selection can be carried out.

Additional keywords: Resistance, criteria for resistance, discriminative selection.

Introduction

Control of *Myzus persicae* in lettuce (*Lactuca sativa*) will be simplified by the use of resistant cultivars. After screening the IVT *Lactuca* gene bank several partially resistant plant genotypes were found (Eenink and Dieleman, 1977). However, both internal and external factors influence the interaction between host and *M. persicae* and thus the resistance level (Müller, 1961, 1966; van Emden et al., 1969; van Emden, 1972). Therefore a better knowledge of these factors is needed, both for the improvement of screening methods as the evaluation of the resistances found.

In this paper results are given of research on the influence of the factor plant age on aphid development.

Materials and methods

In five experiments with the susceptible lettuce cultivar Taiwan and the partially resistant cultivar Plenor the influence of plant age was investigated. At the time of inoculation the plants were between 14 and 45 days old. The parameters were: the

remaining percentage of aphids (RPA), aphid developmental rate, aphid biomass and larvae production.

Plants of the two cultivars were grown in a glasshouse at temperatures varying between 20°C (day) and 15°C (night). Experiments I and II were made under natural light conditions in summer while experiments III, IV and V took place in autumn under natural light with additional illumination for 16 hours of 7.2 W/m² visible radiation.

In the first three experiments 10 first instar larvae (L1 less than 24 hours old) were placed on the second leaf of each plant and prevented from spreading to other parts of the plant. In experiments IV and V 20 first instar larvae were put on each plant and in contrast to the other three experiments the aphids were allowed to distribute all over the plant.

Further details of materials and methods are given under 'Results' in Tables 1 and 2.

Results

Results of experiments I, II and III in which aphids only developed on the second leaf are given in Table 1. Results of experiments IV and V, with aphid population development on the whole plant, are given in Table 2. Though the experiments were carried out in different seasons and thus under different environmental conditions, the results are rather similar.

Table 1 shows large differences between the cultivars Taiwan and Plenos both for RPA, developmental rate, insect biomass, and larvae production. On the partially resistant genotype RPA is always lower, the aphids become fully grown later and their biomass and larvae production are smaller.

With the exception of RPA these parameters are also influenced by plant age for aphids developing and growing on the second leaf. Aphid development from first instar larvae to adult seems to be slower if plants are younger especially with the resistant genotype (experiment III). An effect of plant age is also found for biomass, both with the susceptible and the resistant genotype. In the three experiments, aphids were heavier on older plants than on younger ones. Plant age effect is not significant for larvae production in these experiments, maybe as a result of a too short measuring period (4 days).

The absolute difference in biomass production ($b_s - b_r$) between the susceptible (s) and the resistant genotype (r) – important for selection – was not clearly influenced by plant age, in contrast to the ratio b_s/b_r which decreased if plants were older.

Results of experiments IV and V are shown in Table 2. A significant increase of the RPA with plant age occurs with the susceptible genotype. This effect though not statistically significant, was also present for the resistant genotype. A similar effect of plant age was found for number of aphids per plant after two weeks, insect biomass and mean larvae production per adult per week. Aphids therefore appear to grow better and produce more larvae on old than on young plants.

The absolute differences between the susceptible and the resistant genotype for the above characters increased with plant age. The ratio s/r , however, decreased for most characters with plant age as was also found in experiments I, II and III.

Table 1. Effect of plant age on RPA, development, growth and larvae production of *Myzus persicae* on the second leaf of lettuce plants.

Experiment	Plant age ¹	Plant 'Taiwan' (susceptible)				'Plenos' (partially resistant)									
		RPA ² % adults after			biomass ³ m ⁴ s ⁵	larvae production ⁶ m s	RPA		% adults after		biomass m s	larvae production m s			
		7	8	9 days			7	8	9 days						
I	15	76		502 ^a	110.4	10.2 ^a	5.9	42							
	22	72		566 ^b	96.1	8.3 ^a	7.3	48							
II	14	72		499 ^b	136.5			56							
	18	48		514 ^{ab}	76.7			36							
	22	56		531 ^{ab}	88.6			52							
	25	44		549 ^a	118.2			40							
III	17	70	40	407 ^c	82.6	7.4 ^{ab}	2.8	30	0	58	100				
	24	64	40	450 ^b	87.9	10.5 ^a	4.4	48	0	72	100				
	31	68	50	470 ^b	120.5	5.6 ^b	3.6	36	6	88	100				
	38	73	52	582 ^a	96.8	9.4 ^a	4.7	36	17	80	100				
	45	68	42	556 ^a	134.1	10.1 ^a	1.5	*	*	*	*				

¹ Plant age in days at the time of inoculation.² RPA = Remaining percentage of aphids 7 days after inoculation.³ Biomass = weight of aphids (in µg) 7 days after inoculation.⁴ m = mean.⁵ s = estimate of standard deviation.⁶ Larvae production = production per aphid in 4 days.Use of different letters^{a, b} and ^c indicate significant differences at 1% level per experiment per character per genotype between plant ages. * = not investigated because of a shortage of plants.

In experiments I and III, 10 plants and in experiment II 5 plants per genotype per age were used.

Tabel 1. Effect van leeftijd van de plant op het aanwezige aantal luizen 7 dagen na inoculatie, ontwikkeling, groei en larvenproductie van *Myzus persicae* op het tweede blad van slaplanten.

Table 2. Effect of plant age on RPA, larvae production and growth of *Myzus persicae* on lettuce plants.

Experiment	Plant age	'Taiwan' (susceptible)				'Plenos' (partially resistant)					
		RPA	number of aphids after 14 days	biomass		mean larvae prod. per adult/week	RPA	number of aphids after 14 days	biomass		mean larvae prod. per adult/week
				m	s				m	s	
IV	16	23 ^b	46 ^c	28.4	98.4	10.0	9 ^a	2 ^c	144 ^b	52.4	1.1
	30	50 ^a	124 ^b	54.1	117.8	12.4	11 ^a	8 ^b	203 ^b	88.1	3.6
	44	57 ^a	254 ^a	22.8	141.0	21.2	24 ^a	24 ^a	302 ^a	146.0	4.8
V	10		53 ^b	21.2				4 ^b		5.4	
	21		34 ^b	11.3				1 ^b		1.7	
	45		114 ^a	53.6				16 ^a		11.9	

For legend see Table 1.

In both experiments 5 plants per genotype per plant age were used.

Tabel 2. Effect van leeftijd van de plant op het aanwezige aantal luizen na 7 dagen, larvenproductie en groei van *Myzus persicae* op slaplanten.

Discussion and implications for resistance breeding

The results show that plant age influences the relationship between lettuce and *Myzus persicae*. Especially in the experiments where aphids were allowed to utilize all parts of the plant which is the natural situation, aphids developed faster and grew better on older plants than on younger ones. This increase of 'susceptibility' of both the susceptible and the resistant cultivar agrees with our results from investigations on the influence of leaf age (Eenink and Dieleman, 1977), but differs from the results of Abernathy and Thurston (1969) for the relationship between *Nicotiana* and *M. persicae*. These authors found that the toxicity of resistant cultivars increased as the plants matured.

The better development and growth of *M. persicae* on older plants or older leaves was also found in other crops such as *Solanum* (Gibson, 1971) and *Brassica* (Wearing, 1972) and might be correlated with high(er) concentrations of soluble nitrogen such as amino acids and amides in the phloem or low concentrations of secondary plant substances such as thiocyanates (Mittler, 1958; van Emden et al., 1969; van Emden, 1972).

The effect of plant age on the criteria used for the selection of resistant cultivars has implications for resistance breeding. Testing young plants might result in an overestimation of the resistance level as these plants are less attractive to *M. persicae*, leading to selection of only seemingly resistant plants. If older plants (e.g. 30–40 days old) are tested the overall resistance level of the plant population may decrease but the absolute differences between partially resistant and susceptible genotypes increase so that a better discriminative selection for resistance can be carried out.

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Samenvatting

Ontwikkeling van Myzus persicae op een partiëel resistent en op een vatbaar genotype van sla (Lactuca sativa) in relatie tot leeftijd van de plant

De relatie tussen sla en *Myzus persicae* wordt door zowel interne als externe factoren beïnvloed. Voor de verbetering van toetsmethoden en voor de evaluatie van gevonden resistenties, is meer kennis omtrent deze factoren noodzakelijk.

In vijf proeven (I–V) werd de invloed van leeftijd van de plant op het resistentieniveau onderzocht bij een partiëel resistent en een vatbaar ras. Criteria voor resistentie waren: overblijvend percentage luizen 7 dagen na inoculatie, ontwikkelingssnelheid van de luizen, de insekt-biomassa en de larvenproductie.

Het bleek dat de groei en de ontwikkeling van de luizen op oudere planten beter was dan op jongere. Dit resulteerde in een afname van het resistentieniveau bij zowel het partiëel resistente als het vatbare genotype. De absolute verschillen tussen het vatbare en het resistente genotype voor bepaalde eigenschappen zoals biomassa namen echter toe naarmate planten ouder waren in de experimenten IV en V waarbij de luizen toegestaan was zich op alle delen (bladeren en stengel) van de planten te vestigen. Op

basis van deze toegenomen absolute verschillen tussen resistente en vatbare planten is het dus beter om bij oudere planten (bijv. 30–40 dagen oud) op resistentie te selecteren.

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