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"BREEDING FOR RESISTANCE TO INSECTS AND MITES"

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INTRODUCTION

After a first meeting of this working group in the Netherlands (Wageningen, 1976) and a second in the United Kingdom (Canterbury, 1980) this third meeting was held in France. The stimulating effect of a meeting held in one's own country became evident from the relatively large number of French participants (19), who did not all participate in the earlier meetings. For the next meeting again a different country has been chosen.: Sweden, 1986.
Altogether 42 participants from 11 countries attended the meeting. Seven participants were representatives of private breeding companies, demonstrating their commercial interests in breeding for resistance to insects and mites. This private attendance also reflects that this working group belongs to both the OILB/SROP and EUCARPIA, the European Association for Research on Plant Breeding, which brings together public and private breeders.
At the meeting 32 papers, covering a wide range of crops, were presented and discussed. In a number of presentations progress was evident, resulting in routine breeding programs and the release of resistant germplasm. The exchange of ideas and experiences on test procedures remains the strength of the working group. Cooperation between plant breeders and entomologists again proved to be very useful in discussing the appropriateness of these test procedures.
The perfect "environment" of the meeting, a vacation resort on the Atlantic coast, where all participants were so to speak confined, contributed largely to the success of the meeting.
The local organizers, Dr.P. Anglade and his assistants, have to be complimented and thanked for having organized an interesting meeting in a pleasant French setting with a Basque flavor.

Orlando de Ponti
convenor

The proceedings contain the extended summaries of all papers, which were prepared before the meeting and distributed at registration in an attempt to reduce language barriers and stimulate the discussion and informal exchange of information.

COMPARAISON DE L'EVOLUTION AU CHAMP DES POPULATIONS DE PUCERONS DES CEREALES SUR DIFFERENTS CULTIVARS DE BLE D'HIVER

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Depuis 1978 nous avons étudié l'évolution de populations de *Sitobion avenae* F., *Rhopalosiphum padi* L. et *Metopolophium dirhodum* WLK. au Rheu, sur différentes variétés de blé d'hiver. Ceci nous a permis :

de juger de la répétitivité des résultats obtenus, durant cinq années consécutives afin d'avoir une idée de la stabilité des différences observées concernant 4 ou 5 cultivars.

d'étendre le champ de nos investigations, pendant une période de temps limitée (deux ans) à une gamme plus importante de cultivars : 10 en 1981, 15 en 1982.

Intensité de la colonisation par les pucerons ailés :

Pour une même date et une même densité de semis on n'a jamais trouvé de différences significatives entre les quantités de pucerons ailés colonisant les différents cultivars, quelles que soient l'espèce de puceron et l'époque de la contamination (automne ou printemps). Même si, comme des résultats de laboratoire semblent l'indiquer, les pucerons peuvent coloniser préférentiellement certaines variétés, les différences au champ ne paraissent pas être suffisamment fortes pour être aisément mises en évidence.

Importance des populations au cours du printemps :

Dans presque tous les cas les différences intervariétales sont faibles pendant le début de la phase de croissance des populations de pucerons. Elles se manifestent par la suite aux niveaux des maxima atteints et de la durée de présence des pucerons sur chaque cultivar, ceux-ci quittant certaines variétés plus rapidement que d'autres. Ces différences intervariétales sont plus manifestes lorsqu'on envisage la somme au cours de la saison des quantités journalières de pucerons de chaque espèce, c'est à dire l'intégrale des courbes de développement (indice Rautapää).

Dans le cas de *M. dirhodum*, les différences entre niveaux de population sont généralement faibles et rarement significatives. Seule la variété russe Mironowskaïa 808 semble régulièrement moins colonisée que les autres cultivars. Malheureusement un certain nombre de ses descendants à meilleur rendement et plus adaptés aux conditions ouest-européennes, ne paraissent pas avoir gardé cette faculté de moins multiplier *M. dirhodum* au champ.

En ce qui concerne *S. avenae* et *R. padi* les différences intervariétales sont plus fortes mais il est très rare que les différences entre extrêmes soient d'un facteur 10 ; elles sont généralement d'un facteur 2 ou 3.

Le classement des cultivars d'après l'importance de leur infestation est assez instable, d'une part selon les années, d'autre part pour une même année selon la date de semis et l'époque de la contamination (automne ou printemps). Les niveaux de population atteints semblent en partie liés à l'évolution de l'état sanitaire du cultivar, à sa plus ou moins bonne adaptation aux conditions écoclimatiques locales, à sa précocité ou à sa morphologie. Seuls quelques résultats sont constants selon les années et les conditions de culture : Maris Huntsman qui est une variété tardive à fort développement végétatif et peu sensible aux maladies foliaires est toujours, ou presque, colonisée plus longtemps et plus abondamment par *S. avenae* et *R. padi*, que des cultivars précoces dont le feuillage se dessèche rapidement pour des causes pathologiques comme Roazon, ou que des cultivars barbus dont les épis semblent moins propices à la multiplication des pucerons, comme Fidel. La variété Capitole est généralement fortement infestée, mais de manière plus irrégulière que Maris Huntsman.

Cette étude trouve son prolongement dans le travail de J.P. DI. PIETRO qui a entrepris l'analyse en conditions contrôlées des différentes composantes du taux d'accroissement potentiel des pucerons des céréales sur les mêmes cultivars de blé, afin de pouvoir mettre en évidence d'éventuels phénomènes de résistance en minimisant les différences dues à la phénologie et à la sensibilité des variétés aux maladies.

QUELQUES FACTEURS CONDITIONNANT L'EXPRESSION DU POTENTIEL BIOTIQUE DES PUCERONS DES CEREALES SUR DIFFERENTS CULTIVARS DE BLE D'HIVER

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Afin de déterminer si les différences d'infestation de cultivars de blé d'hiver, observées au champ par C.A. DEDRYVER, sont uniquement d'origine circonstancielle (phénologie, état sanitaire,...) ou si elles procèdent au moins partiellement d'un phénomène de "résistance", nous avons entrepris une série d'études en conditions contrôlées visant à préciser, sur chaque cultivar étudié :

- les paramètres d'accroissement des populations de pucerons virginipares, afin de caractériser la "sensibilité" de chaque cultivar par un taux intrinsèque d'accroissement calculé pour les 3 principales espèces de pucerons des céréales.

- l'expression du phénomène de préférence/non-préférence par les virginipares ailés ;

- l'orientation morpho-génétique du développement vers la production d'ailés : l'aptitude d'un cultivar à favoriser la production d'ailés pouvant être considérée comme défavorable au maintien, de colonies denses de pucerons et, par là-même comme un facteur de résistance.

En premier lieu, nos essais n'ont porté que sur l'espèce *Sitobion avenae* F. et sur les 15 cultivars étudiés sur le terrain en 1982, à savoir : 5 variétés cultivées, (CAPITOLE, CHAMPLEIN, FIDEL, MARIS HUNTSMAN et ROAZON) et 10 lignées ou variétés susceptibles d'être utilisées dans l'amélioration génétique des blés d'hiver, parmi lesquels se trouvent MIRONOVSKAIA 808 et KAVKAZ 10-2.

Jusqu'à présent, on a étudié en conditions contrôlées (température 20° C et photopériode de 18 heures) :

- la fécondité et la longévité des virginipares aptères de *S. avenae* sur les 15 lignées, au stade plantule, cultivées sur milieu gélosé (10 à 20 individus par lignées).

- la durée de développement larvaire, la mortalité et le rapport ailés/aptères formés sur les lignées au stade début épiaison (50 à 100 individus par lignées).

- la colonisation par des virginipares ailés fournis en continu par un élevage, sur 7 blocs comprenant chacun un plant au stade montaison par lignée.

Pour les deux premiers essais, une Analyse en Composantes principales a donné les résultats suivants :

Les données sont bien résumées par les 2 premières composantes principales (66 % de l'inertie) : la première est corrélée positivement avec les caractères fécondité, longévité, étalement des pontes et corrélée négativement à la durée de développement et la mortalité larvaires. La seconde est très corrélée positivement au pourcentage d'ailés produits et négativement à celui des aptères.

La position des individus (cultivars) remarquables illustre une tendance favorable (notée + dans le tableau suivant) ou défavorable (notée -) à l'expression d'une forte capacité d'accroissement des populations de *S. avenae*, par exemple, une fécondité forte est, bien sûr, jugée favorable, un fort pourcentage d'ailés produits est, au contraire, jugé défavorable.

Cultivars	Longévité	Fécondité	Durée de développement	Mortalité	% d'ailés
CAPITOLE	+	+	+	+	0
FIDEL	-	-	-	-	0
ROAZON	+	+	+	+	-
(MIXB) 5-4-2	-	-	-	-	-
(- bulk A 104	+	+	+	+	0
(- bulk A 207	-	-	-	-	0
L. 707	0	0	0	0	+
MIRONOVSKAIA	-	-	-	-	0

Ainsi des lignées comme FIDEL, (MIXB) 5-4-2, (MIXB) bulk A 207 et MIRONOVSKAIA seraient globalement défavorables alors que CAPITOLE, (MIXB) A 104 et, dans une moindre mesure, L 707 seraient favorables à *S. avenae*. Pour ROAZON deux effets contradictoires se manifestent : forte production d'ailés mais paramètres d'accroissement des populations élevés.

Pour le 3e essai, un test de KRUSKALL et WALLIS a mis en évidence des différences très significatives entre lignées pour les 2e et 3e jours de colonisation : la lignée L 755 était plus colonisée que toutes les autres. Ces différences s'estompent mais restent significatives du 4e au 5e et dernier jour d'observation. Dans tous les cas, la lignée KAVKAZ était (de manière non significative) la moins colonisée, résultat qui pourrait être confirmé par une expérience plus approfondie.

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COMPONENTS OF HOST RESISTANCE TO THE GRASS APHID *METOPOLOPHIUM FESTUCAE* (THEOB.)

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Metopolophium festucae, unlike *Metopolophium dirhodum* wlk. and *Sitobion avenae* F., is not usually thought of as a serious pest of cereals. However it probably has more potential to cause damage to cereals than either of the two main pest species. Reports of *M. festucae* have mostly been concerned with the damage it has caused to grassland, but occasionally outbreaks occur in cereals where the damage is so severe that the crops are ploughed in (Massee 1935).

M. festucae reaches its peak abundance in cereals earlier in summer than do the other cereal aphids, but very rarely are its numbers as high as in grassland.

The question posed here is: which components of resistance maintain low levels of *M. festucae* infestation on wheat?

M. festucae has been cited as occurring on 23 species of *Gramineae* including cultivars of wheat, oats and barley. The following agricultural grasses and cereals were screened for antibiotic resistance to *M. festucae*: *Dactylis glomerata* L., cv. Cambria; *Festuca pratensis* Huds. cv. S215; *Festuca rubra* L. cv. Echo; *Loluim multiflorum* Lam., cvs. RVP Lemptal and Sabalan tetraploid; *Loluim perenne* L., cvs. Cropper and Reveille tetraploid; oats cv. Maris Quest; *Phleum pratense* L., cv. S48 and winter wheat cvs Bouquet and Hobbit. The experiments, conducted at 20^{o}C, showed that seven-day reproduction was higher on wheat than any of the grasses.

Host preference experiments carried out in a flight chamber measured the numbers of alatae taking off from and the number of nymphs left behind on, a selection of grass and cereal hosts. The number taking off from wheat were greater than the numbers taking off from the most important agricultural grass, perennial ryegrass. This infers that the aphids settling preference may be an important component of wheat resistance to *M. festucae*.

Settling behaviour experiments were conducted, measuring the number of probes, duration of probes and time spent walking on a perennial ryegrass and wheat host, in an attempt to investigate further this aspect of resistance.

In conclusion, wheat resistance to *M. festucae* appears to influence the settling behaviour of alatae, but the nature of this resistance is such that if the aphid does remain on the host then its reproduction is not affected.

(continued from page 12)

On peut d'ores et déjà noter que le caractère de "sensibilité" ou de "résistance" peut se manifester de manières différentes et, semble t-il, indépendantes d'un cultivar à l'autre : attractivité plus ou moins grande à l'égard des virginipares ailés infestants, favorisation ou non de l'accroissement des populations de pucerons, induction plus ou moins fortes de la production d'ailés. Ces tendances confirment d'autre part les résultats de C.A. DEDRYVER dans le cas de la variété FIDEL (dans une moindre mesure, MIRONOVSKAIA) qui semble, dans les deux conditions peu propice à la multiplication de *S. avenae* et dans le cas de CAPITOLE, qui parait plutôt multiplicatrice. Au contraire, MARIS HUNTSMAN ne se distingue pas en conditions contrôlées, par conséquent les fortes infestations constatées au champ ne pourraient être dûes qu'à sa tardivité et son fort développement foliaire. Enfin, pour ROAZON, les effets contradictoires révélés par nos essais semblent être infléchis, au champ dans le sens d'une multiplication faible des *S. avenae*, du fait de sa précocité et de sa sensibilité aux maladies foliaires.

SCREENING FOR RESISTANCE TO SITOBION AVENAE IN WHEAT

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I reported earlier (Lowe, 1981) the development of a method to demonstrate differences in the resistance of wheat (Triticum aestivum) to the grain aphid (Sitobion avenae) by testing plants in the glasshouse during the stem elongation phase of growth. A high degree of repeatability with the standard cultivars Maris Huntsman, susceptible and Kador, resistant was confirmed during application of this method to groups of winter wheat cultivars (Lowe, 1982). Variation between susceptibility and resistance to an extent similar to the differences between the standards was found both amongst cultivars that had been dominant in British agriculture since 1940 and amongst cultivars currently recommended for commercial use. Cappelle Desprez, a cultivar that was widely predominant for more than 15 years appeared slightly resistant. Similar variation between resistance and susceptibility was observed amongst spring wheat breeding lines at Cambridge, indicating that location of sources of resistance was not a key problem in breeding for resistance.

A simplified modification of the glasshouse method was extensively tested as a potential screening method using randomly labelled plants of spring wheat lines known to vary in resistance. Usually 15 plants of each line were included in each test and these were scored individually for aphid number on a 0 to 9 scale; plants with scores 0 (no aphids) to 4 (below average aphid numbers) were classed 'resistant' and plants scored 5 or more were classed 'susceptible'. The resistance or susceptibility of a test entry was assessed from the mean score over 12 to 15 replicate plants and fromthe proportion classed 'resistant'. Test results were little affected by variations in a number of technical factors, including season and use of fertilisers, but discrimination between test entries was greater with older plants, provided the test was completed before ear emergence. Repeatability similar to that of the more detailed method was found in tests with 16 wheat stocks, and variation in resistance was also demonstrated in T. monococcum, including a number of highly resistant entries. Duplicated tests appeared a

necessary minimum for assessing unknown stocks, so that tests on 84 entries occupied glasshouse space to the extent of 108 m^2wks.

Other experiments have been undertaken to develop a method of selecting for resistance to S. avenae in the field. Enhancement of aphid populations by spraying with carbaryl (Lowe & Benevicius, 1981) and releasing cultured aphids produced a high level of infestation in 1982 that was more easily assessed than low level natural populations observed in 1980. These populations were quantified by scoring a sample of tillers from each plot using a logarithm base 2 scoring scale for the number of aphids on a tiller. Average numbers of aphids per tiller were estimated by an empirical formula. A direct visual score of aphid infestation on each plot was also made by independent observers on a number of occasions. There were differences for some cultivars between visual scores and the assessment from sampling tillers, and other differences were observed between the resistance status of adult plants in the field and results obtained in glasshouse tests.

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THE POTENTIAL OF ANTIBIOSIS FOR REDUCING OUTBREAKS OF *Sitobion avenae* ON WHEAT

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Simulation models of pest population dynamics can be used to indicate what feature of crop plants should be selected for if the reduction of aphid damage is desirable.

The effect of partial resistance can be mimicked by applying a sensitivity analysis to the simulation model developed by Carter (1978). This enabled Carter and Dixon (1981) to suggest that it may be more effective to select for antibiosis rather than antixenosis, and pinpointed survival and reproduction as the most significant parameters in the population growth of the English grain aphid, *Sitobion avenae* on wheat, *Triticum aestivum*.

Such simulations can also be used to decide on the level of partial resistance necessary to exert control. The approach here, using the model for the *S. avenae*-wheat system, has been to assess antibiotic levels in present modern stocks and to evaluate these in terms of preventing outbreaks of the aphid.

The results used were from varieties that represented the extremes of the range of known resistance in spring wheat stocks. Incorporation into the model of values for duration of development and reproductive rate of the aphid gave marked differences in the predicted peak numbers/tiller for the most and least resistant varieties. Under the climatic conditions that have prevailed over the last 6 years it was predicted that the most resistant variety would have had up to 70% and generally more than 50% fewer aphids than the most susceptible variety. However promising, the economic usefulness of such reductions is limited if insecticide is sprayed when numbers become economically damaging. Such resistance would only prevent an outbreak in those years when few aphids infest the crop, which is uncommon eg. the level of resistance used would not have prevented outbreaks in any of the years studied although there would have been some benefit from reduced damage.

Greater levels of antibiosis do exist in the primitive cultivated diploid wheat *Triticum monococcum*. Using data supplied by G. Lee at Reading University, UK, reductions of 80% in peak numbers were more common.

Resistance at this level would prevent more *S. avenae* outbreaks and so would be of great value if it can be transferred into modern *T. aestivum* varieties.

Preliminary studies indicate a positive association between antixenosis and antibiotic resistance, the additive effect of which needs to be elucidated. Thus there is scope for using the full range of plant resistance possibly in combination with other factors in the cereal system to reduce incidence of cereal aphid outbreaks.

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ETUDE HISTOLOGIQUE DE LA PIQÛRE DE *Rhopalosiphum padi L.* (HOMOPTERES-*Aphididae*) SUR DEUX LIGNEES DE MAÏS

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Depuis quelques années, des observations et des relevés chiffrés au champ, en particulier sur des essais diallèles destinés à la sélection de maïs vis-à-vis de la Pyrale (*Ostrinia nubilalis Hbn*) nous ont montré que les différences d'infestation des plantes par deux espèces de pucerons nuisibles aux cultures, *Metopolophium dirhodum Walk* et *Rhopalosiphum padi L.*, avaient une explication génétique.

Nous avons choisi pour la présente étude deux lignées, LO 516 et F 564. La première est sensible aux deux espèces de pucerons. La deuxième est résistante, et montre en plus de fortes réactions d'hypersensibilité (stigmonose) aux piqûres de *M. dirhodum*. Au champ, on a pu noter des différences significatives dans le développement des populations des pucerons des deux espèces sur des hybrides simples ayant l'une de ces lignées comme parents, (en 1980), et sur les lignées elles-mêmes (en 1981).

Pour préciser l'évolution et le comportement de piqûre des pucerons en conditions contrôlées, nous avons cultivé les deux lignées de maïs en chambre climatisée, sur vermiculite et solution nutritive. Pour chaque répétition, cinq aptères du dernier stade larvaire étaient installés pendant une semaine dans une cagette cylindrique d'un centimètre de diamètre. A partir du 2e jour, on notait quotidiennement la mortalité et on éliminait les larves nouveau-nées. En fin d'expérience, les fragments de feuille correspondant à chaque cagette ont été prélevés et placés dans du FAA, fixateur-conservateur. Puis les échantillons ont subi une déshydratation par l'alcool isoamylique, et une inclusion dans la paraffine. Des coupes sériées, de 18 microns d'épaisseur, ont été effectuées perpendiculairement aux nervures. Les trajets de piqûre et les différents tissus végétaux ont été mis en évidence par la double coloration Bleu de Méthylène - Rouge de ruthénium. Les observations et comptages ont porté sur au moins 500 coupes de 5 échantillons dans chaque cas.

Le tableau ci-après donne les résultats concernant *R.padi* placé sur la feuille n°4 de maïs au stade 4-5 feuilles. Ils sont ramenés à 2500 coupes, représentant 140 mm^2 de feuilles soumis aux piqûres.

Lignée	Nombre de pucerons x jours de survie	Total des piqûres	Piqûres par mm^2	Piqûres par puceron x jour	Terminaisons dans Parenchyme	Terminaisons dans Nervures (Liber)	%Nervures (% Liber)
LO 516	140	129	0,92	0,92	0,47	0,73 (0,16)	79,3 (17,4)
F 564	122	580	4,14	4,75	2,73	2,27 (1,02)	47,8 (21,5)

Sur LO 516, la survie a été un peu meilleure, et surtout le nombre de piqûres a été beaucoup plus limité que sur F 564. On retrouve ici un phénomène très souvent observé chez les insectes piqueurs, et que nous avions déjà constaté*. La variété résistante reçoit, à quantité comparable d'insectes, un plus grand nombre de piqûres ou d'essais de piqûres que la variété sensible sur laquelle les individus voient leurs besoins satisfaits sans changer de site d'alimentation.

* (MOREAU J.P. et BOULAY C., 1967 - Mode de piqûre de trois cicadelles *Euscelis plebejus Fall. Macrosteles sexnotatus Fall.* et *Aphrodes bicinctus Schrk.* Etude histologique. Etudes de virologie. Ann. Epiphyties 1967, n°18 - 133 - 141.)

LA RESISTANCE A LA PYRALE, OSTRINIA NUBILALIS HBN., LEP. PYRALIDAE, DANS UN DIALLELE DE 14 LIGNEES PRECOCES DE MAIS, ZEA MAYS

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La pyrale est actuellement le principal ravageur du maïs en France. Nous poursuivons depuis près de 20 ans un travail de recherche pour la résistance génétique à cet insecte. Des méthodes d'infestation artificielle et d'observation ont été mises au point pour les conditions françaises, puis appliquées à l'ensemble du matériel végétal que nous avons créé ou introduit. Elles ont permis de trier des génotypes résistants.

Nous avons voulu expérimenter l'hérédité de ce caractère au sein d'un diallèle de 14 lignées qui paraissaient manifester divers niveaux de résistance, dans quatre stations. Les lignées constitutives proviennent des Etats Unis (A 641, A 665), de Bulgarie (BGR 1184), de France (F 231, 248, 264, 1444, 549, 564, 602, 617, 627, 654), d'Italie (Lo 516).

Les hybrides ont été expérimentés en 1979 dans 4 lieux dont 2 non infestés, 1 sous infestation artificielle, 1 sous infestation naturelle.

Les caractères de précocité (floraison et récolte), de rendement, de pourriture des tiges à la récolte, de note générale pyrale, de notes de dissection pyrale ont été observés. Les résultats suivants ont été obtenus.:

Les pertes de rendement dues à la pyrale ont été grossièrement appréciées en calculant la différence de rendement entre lieu non infesté et lieu infesté. La corrélation entre ces pertes et la note pyrale est hautement significative; le gain moyen par point de note générale pyrale en moins est d'environ 4 quintaux/ha. Les notes de dissection pyrale paraissent moins bien corrélées avec les pertes de rendement.

Le modèle de GRIFFING a été utilisé pour étudier l'hérédité de la note générale pyrale. Dans les deux lieux infestés, nous trouvons des effets d'aptitude générale à la combinaison très hautement significatifs. Les effets d'aptitude spécifique à la combinaison ne sont pas significatifs. Ce caractère peut donc être considéré comme largement additif. Les héritabilités sont comparables en conditions d'infestation naturelle ou artificielle.

Aucune relation entre note générale pyrale et productivité n'a été trouvée. Par contre, les hybrides résistants à la pyrale sont statistiquement

plus tardifs et plus résistants à la pourriture des tiges, même en l'absence de pyrale.

Pour conclure, nous pensons que malgré ses imperfections la méthode d'infestation artificielle doit être préférée car elle assure une certaine régularité d'infestation, elle permet de choisir la date en fonction de la précocité du matériel, enfin elle évite les effets de préférence de ponte. Du point de vue du sélectionneur, les méthodes qui exploitent la variance additive paraissent applicables à l'amélioration de la résistance à la pyrale des maïs précoces européens, à condition que la nette association entre précocité et sensibilité puisse être surmontée.

THE MONOPLOID METHOD OF DEVELOPING NEW LINES OF CORN (ZEA MAYS) RESISTANT TO CORN BORER (Ostrinia nubilalis Hübn)

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W ithin the scope of the IWGO programme, after each cycle, we created synthetic materials. From these materials and from our best hybrids, in two years, we developed through the monoploid method new lines which will help the breeding work.

The combining ability of these lines issued from the monoploid method is not inferior to the lines issued from the traditional method which need 8 to 10 cycles.

CHASE proposed firstly, in 1952, the monoploid method to obtain inbred lines. Two markers are known, one is on the roots, the second is on embryo marker. We only use the second one (the Purple Embryo Marker : PEM) furnished by CSETNEKI in 1976. When the source material is crossed with the PEM, the endospermium and the embryo colored dark (fig. 1). Dark embryo kernels are rejected. The aleuron colour is unimportant (fig. 2). The haploid plants were not treated with colchycin. They are male sterile in 99,9 per cent.

The following points are necessary to be successful in this method :

1. The PEM must be wholly homozygote line.
2. Castration is necessary to avoid the self pollination (fig.3)
3. Don't use fresh markers's pollen shed (fig. 4)
4. Source material must be chosen from the best hybrids, composites and synthetics.
5. As far as possible, use as testers the lines of group XY different from group AB - american classification) with good combining ability. The sister line crosses (SLC) can be used equally as marker but they must not be related to the source material.
6. We must make a diallel within the lines which have a good combining ability.

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COMPARAISON DE VARIETES DE MAIS POUR LA TOLERANCE A LA PYRALE

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Pour juger la valeur d'une variété hybride de maïs vis-à-vis de la pyrale *Ostrinia nubilalis*, on peut soumettre un petit échantillon de plantes à une infestation artificielle contrôlée et évaluer les réactions de la plante par une "note générale de dégât pyrale" dont on sait qu'elle est, pour un ensemble d'hybrides, corrélée avec les variations de rendement entrainées par la présence de l'insecte (KAAN et al., 1983).

On peut également réaliser des essais comparatifs de variétés dans des conditions d'infestation naturelle de pyrale de niveau élevé. Dans ce cas, on est tributaire d'une infestation naturelle dont les niveaux peuvent être variables et d'autre part des phénomènes de préférence pour la la ponte (ANGLADE DERRIDJ et DURAND, 1979 ; DERRIDJ, 1983) sont susceptibles de biaiser les résultats.

Depuis plusieurs années, nous réalisons dans des régions naturellement peu ou pas infestées par la pyrale, des essais au champ de variétés dans des dispositifs expérimentaux comprenant des sous-parcelles artificiellement infestées par des pontes de pyrales et des sous-parcelles témoins. Les comparaisons des rendements obtenus dans les deux cas constituent des mesures de la tolérance de la variété à la présence de l'insecte.

Les trois exemples que nous présentons ici illustrent les enseignements que l'on peut tirer de telles expérimentations.

Dans le premier cas, deux variétés nouvelles ont été comparées à un témoin de sensibilité et à une variété commerciale. On voit nettement que le classement des variétés est modifié en présence de pyrale.

Rendement	Témoin sensible	Témoin cultural	Monclair	HD 234
Parc.témoin	81.8 a	70.5 c	76.6 b	73.9 bc
Parc. pyrale	63.2 b	63.1 b	68.9 a	68.5 a

Le deuxième cas comprend la comparaison de 6 hybrides constituant les combinaisons diallèles entre 4 lignées jugées résistantes à la pyrale toujours avec des témoins sensible et cultural. On peut ainsi mesurer les AGC des lignées parentales pour la modification de rendement entraînée par la présence de l'insecte.

Rendement	Témoin sensible	Témoin cultural	F478	W375B	F1417	BGR 447
Parc. témoin	88.7	73.3	81.7	81.2	91.0	86.2
Parc. pyrale	61.6	67.1	76.7	80.9	90.3	81.7
Diff.de rend^{t}	- 30,5 %	- 8,5 %	- 6.1 %	- 0,4 %	- 0,8 %	- 5,2 %

De plus, la considération du poids unitaire du grain montre que les différences de rendement entre parcelles infestées et parcelles témoin n'est pas imputable seulement à l'action sur cette composante du rendement qui n'explique respectivement que 32 et 45% des baisses de rendement constatées sur les deux premières variétés témoins.

Le troisième cas donne un exemple des réactions des hybrides à deux doses d'infestation 2 et 6 plantes par plante :

Rendement et % de réduction	Variété témoin	V1	V2	V3
Dose pyrale 0	67.7	90.7	87.2	84.3
" 2	55.1 19%	80.7 11%	71.4 18%	75.2 11%
6	36.2 47%	62.4 31%	50.0 43%	61.2 27%

On voit que la variété V2 réagit comme le témoin à un niveau moyen de rendement supérieur. Ces deux variétés sont moins tolérantes à la pyrale que les variétés V1 et V3.

D'autre part, en comparant les notes générales d'attaque pyrale et les diminutions de rendement, on constate que la variété V2 accuse une baisse de rendement de 10 q/ha par point de note contre environ 5 q/ha seulement pour les autres variétés. Dans ce cas des dégâts apparents de niveau moyen peuvent être associés à une forte baisse de rendement.

TOLERANCE DE POPULATIONS DE MAIS ISSUES DE CROISEMENTS (MAIS TEMPERES & MAIS TROPICAUX) AUX ATTAQUES DE *SPODOPTERA FRUGIPERDA* ET *HELIOTHIS ZEA*

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Le maïs en Guadeloupe est cultivé dans des jardins de taille fort variable, en association avec des plantes à tubercules, des légumineuses voire des cucurbitacées. Plusieurs essais en culture intensive de divers types de maïs ont révélé des problèmes phytosanitaires importants. Nous recensons principalement en zone sèche *Spodoptera frugiperda* et *Heliothis zea*, en zone humide *Heliothis zea*, des Helminthosporioses et la Rouille américaine.

Nous observons pour *Spodoptera frugiperda* trois périodes de maximum de présence larvaire : stade jeune du maïs, épiaison, maturation des épis. Ce schéma de "trois générations"est compliqué par la présence constante de femelles provenant de l'extérieur et l'attractivité possible de certains stades phénologiques. Nous ne relevons la présence d'*Heliothis zea* que lors de la maturation des épis. La répartition des attaques est plus homogène pour *H. zea* dont les oeufs sont pondus isolément que pour *S. frugiperda* dont les oeufs sont déposés en groupe de façon dispersée mais dont les larves sont mobiles (homogénéisation progressive).

Notre travail a pour objectif d'associer les caractères de productivité et de précocité des maïs tempérés aux caractères de résistance aux Noctuelles (S.f. et H.z) des maïs tropicaux dans une forme génétique assez souple et de reproduction possible par l'agriculteur (variétés - population) ou plus performante (lignées, hybrides, synthétiques ?).

Pour ce faire nous avons constitué une population-source. Elle est issue de croisements impliquant des hybrides doubles tempérés INRA et du matériel tropical; suivie d'une génération d'autofécondation avec choix, et de deux générations de panmixie.

L'amélioration de cette population source est réalisée par sélection récurrente ; méthode prudente permettant une amélioration progressive de notre matériel et la préservation de la variabilité par intercroisements des meilleurs individus et limitation de la consanguinité . Nos critères de choix sont les suivants : notation de la précocité de floraison et jugement du rendement ; appréciation des dégats des chenilles aux stades "5.6 feuilles" puis "épiaison" pour *Spodoptera frugiperda*, (affectant les potentiels photosynthétique et pollinique des plantes)et sur épis à la récolte pour *Heliothis zea*, (affectant le

rendement en grains).

Deux programmes de sélection ont été entrepris.

- Sélection récurrente basée sur l'aptitude générale à la combinaison: nous souhaitons ainsi sélectionner pour la valeur en croisement dans l'attente d'un progrès pour le rendement, la précocité et la résistance aux Noctuelles et de plus étudier les liaisons entre caractères. Nous avons réalisé un Top-cross puis un test de descendances. Il serait intéressant de mettre en place maintenant l'intercroisement panmictique des individus dont les descendants en top-cross auront été jugés meilleurs ou (et) un test en autofécondation (sélection pour la valeur en autofécondation).

- Introduction d'une lignée américaine d'origine ANTIGUA

Cette opération a pour but d'introgresser des gènes d'une résistance à *Spodoptera frugiperda* présumée intéressante et maintenant vérifiée. Après cette introduction et les deux brassages avec sélection sévère qui l'ont suivie nous nous proposons d'apprécier l'apport de la lignée dans notre population (test de grain génétique).

Les résultats des tests en cours devraient nous permettre de discuter des aspects de la sélection multicaractères, des progrès génétiques réalisés, et des nouvelles orientations à suivre.

PROGRAM AND RESULTS OF THE SCREENING OF MAIZE INBRED LINES FOR THE RESISTANCE TO THE EUROPEAN CORN BORER DONE BY THE IWGO IN 1981-1982

(International Working Group on Ostrinia)

P.ANGLADE and IWGO COOPERATORS

The IWGO group, International Working Group on Ostrinia, is an example of international cooperation in the field of the breeding for resistance of plants to insects. Created in 1968 as an unformal group, it has maintened its activity all along 15 years ; it is now affiliated to Global IOBC.

IWGO joins together entomologists and breeders concerned by the selection of maize resistant or tolerant to the European corn borer *Ostrinia nubilalis*, belonging to research institutes from 14 countries : Austria, Bulgarie, Canada, China, Czechoslovakia, France, Hungary, Italy, Poland, Rumania, Spain, U.S.A, USSR, Yugoslavia. Egypt, India, Portugal and Philippines also temporarily participed to IWGO.

The main IWGO project is the screening of inbred lines exchanged between the participants (4 lines per country for 2 years) for their susceptibility to the ECB. One of the first goals, during the IWGO'meetings, has been the adoption of methods and criteria for the evaluation of the degree of susceptibility of inbred lines common to all the members of the group.

The best lines according to the IWGO evaluation were used for the creation of synthetic varieties distributed among the participating countries: the ECB synthetics IWGO 1 and IWGO 2.

As an example, the results of the 1981-82 project are presented here.

Divided into 2 groups of earliness, 48 inbred lines were tested against standards resistant F505, MR12, A619 or susceptible WF9, W117, F7 according to the main criteria leaf feeding damage and general damage at maturity. Additionnal data have also been collected : number of larvae, precocity and productivity of the lines.

Every member has presented his own results in a data sheet. The data have been first compiled in France, then critically analyzed by a technical committee in Martonvasar, Hungary, with IWGO members from Hungary, Austria, Czechoslovakia, Poland and Yugoslavia.

The results are given on the form of graphics giving the value of the inbred lines according to the main criteria.

Remarks, taking into account the whole set of observations and criteria result to the recommendation for new standards resistant TSPT (China) and susceptible : PLS 25 (Poland), EA 2260 (Spain) and to the choice of the lines to be used in future synthetics IWGO 3. The list of these lines is given here to show the diversity of origins : Austria, A2165 C ; Bulgaria BGAT 630, BG 527/64 B ; Canada CH 591-36, Co 120 ; China TSPT, Si Ping 404 ; Czechoslovakia TVA 2008-3 ; France F244, F515 ; Hungary HMV 618, MR11, DZ7/4 ; Italy Lo543 ; Spain EA1721, EA2973 ; USA A663, A670, CM105 ; USSR Kos L24, Ku 301 ; Yugoslavie ZPL 12221. The IWGO 3 synthetics will be, just as the former, produced by a bilateral cooperation between France and Spain.

A new 2 years project is beginning in 1983. The next IWGO meeting will be held in France in 1984.

UN HYBRIDE DE MAÏS PREFERE PAR LA PYRALE (*Ostrinia nubilalis Hbn.*) POUR PONDRE.

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Depuis 1977 des essais sont poursuivis en Beauce en infestations naturelles afin de comparer la tolérance ou résistance d'hybrides de maïs vis-à-vis de la pyrale *Ostrinia nubilalis Hbn.*.

Nous avons pu mettre en évidence que l'oviposition de l'insecte est fonction de caractères variétaux. A l'aide d'essais diallèles l'apport génétique de certaines lignées sur le dépôt préférentiel d'ooplaques de la femelle a été confirmé. Le classement des hybrides selon ce caractère subsiste quels que soient l'année, l'importance de l'infestation, le nombre de variétés mises en compétitions (10 à 100) et le nombre de rangs sur lesquels sont disposés les variétés (1 ou 2).

L'hybride le plus préféré AXF a été pris en considération et comparé à une variété moins préférée, couramment cultivée LG_{11}. Cela a été fait avec deux objectifs : rechercher et mettre en évidence la ou une des causes de la préférence variétale et tenter d'utiliser en agriculture une variété préféreé comme " plante piège ".

Au cours de deux années consécutives 1981-1982 ont été examinées les concentrations en sucres solubles des feuilles de maïs sur les deux hybrides. La première année seule la feuille 8 qui portait le plus de pontes a été considérée et la seconde année ont été examinés trois niveaux par plante et par variété : celui choisi pour la ponte et deux autres inférieur et supérieur au précédent où il y a peu ou pas de pontes.

Pour un niveau donné la femelle de pyrale pond de préférence sur la variété la plus riche en sucres solubles (surtout glucose et fructose). Le rapport entre les nombres de pontes varie de 2 à 5, selon le dispositif cultural et le stade phénologique des variétés. Toutefois la teneur en sucres solubles ne paraît pas être le facteur essentiel en ce qui concerne le choix du site de ponte sur la plante.

Une expérimentation en laboratoire d'enrichissement en sucres solubles d'une seule variété LG_{11} a été faite, afin de vérifier l'action de ceux-ci sur le choix variétal d'oviposition. Il s'agissait de trempages par les

deux extrémités des feuilles coupées de maïs d'un stade phénologique donné, dans des solutions de saccharose à différentes concentrations. L'effet du glucose et/ou fructose sur le choix du site d'oviposition a été confirmé.

En ce qui concerne l'utilisation éventuelle de ce phénomène en agriculture deux méthodes culturales peuvent être envisagée dans la région parisienne. La première consisterait à cultiver deux rangs de la variété préférée pour l'oviposition sur six rangs d'une variété à protéger. Dans des essais parcellaires (16 rangs de 100 plantes) composés des hybrides AXF et LG_{11}, nous avons observé 5 fois plus de pontes (109 pontes pour 100 plantes) sur AXF et LG_{11}. L'hybride AXF ne provoquant pas d'incitation à la ponte (vérifications en cages monovariétales), on peut dire que dans ce cas avec deux rangs on a réduit deux fois le nombre de pontes potentielles. Il n'a pas été possible dans ce dispositif parcellaire de mettre en évidence les capacités réelles de AXF de réduction du nombre de pontes sur LG_{11} , car les pyrales ont été attirées fortement par les parcelles mixtes.

La deuxième méthode consiste à cultiver en bordure, tout autour du champ (en fourrière) la variété AXF, de façon à concentrer les pontes sur celle-ci et à limiter la migration des adultes vers l'intérieur du champ. Un essai sur un tiers d'ha en infestation naturelle a montré qu'avec six rangs on peut concentrer deux fois les pontes par rapport à la parcelle centrale qui a deux fois plus de plantes. Un calcul théorique nous permet d'estimer que pour protéger un ha, douze rangs de bordure peuvent limiter la densité des pontes au dessous du seuil de nuisibilité (12 pontes pour 100 plantes) lorsque le potentiel de ponte est inférieur ou égal à 28 pontes pour 100 plantes. Il semble que dans tous les cas on abaisse le taux de pontes sur la majorité des plantes.

Des essais de ces deux types de méthodes culturales sont envisagés en plus grandes surfaces. Et une étude au niveau de la région doit nous renseigner sur l'éventualité ou non d'un pouvoir attractif, de ces champs de culture plurivariétale , sur l'insecte à grande distance.

GENETICS OF THE RESISTANCE OF LUCERNE TO THE PEA APHID

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We assesed resistance of varieties of lucerne (*Medicago sativa* L.) to the pea aphid (*Acyrthosiphon pisum* HARRIS) by an antibiosis test which estimates the net reproductive rate of the aphid. There is a significant correlation ($r = 0,6$; 13 d.f) between this test and the mean growth of surviving plantules after a mass infestation with aphids. North american workers usually express pea aphid resistance by seedlings survival following infestation with large numbers of aphids. In our experiments, we found changes of pea aphid resistance in some varieties already tested in North America. The present study is about genetics of the resistance in our conditions. This is a necessary step before beginning any program of selection especially because of the great biological variability of the pea aphid.

All our experiments are done in a growth chamber under controlled conditions (temperature : $20° \pm 1$, 16 hours photophasis). The net reproductive rate of aphids is evaluated during two weeks of breeding of 4^{th} stage larvae (tabl.1). We use six clones of lucerne obtained by dividing six vigorous plants of a nursery. Three clones originate from North American varieties : Lahontan, Resistador, Team. In our former experiments, Lahontan was found resistant to the pea aphid, Resistador and Team varieties were susceptible. The other clones : 12, 58, Europe, are of French origin. They were susceptible during our former estimation. The variance analysis on the parental clones is as follows :

clones	Res.	T.	E.	58	12	Lah.
Net reproduction rate	78,5	65,7	48,8	44,8	29,1	11,2
Signification	———		———			

The diallel crosses are analysed with the GRIFFING method, the estimation of the general combining ability ($= \hat{gi}$) is :

clones	Res.	12	58	T.	E.	La.
$\hat{gi}$	+16.1	+2	+1.6	+1.0	-4.6	-16.1
Signification		———	———			

The variance analysis of these results proves genetic effects. The highest reproductive rate in the crosses is given by the Res. clone, and the smallest by La. clone. The other clones are not clearly different.

The results of the variance analysis of the diallel crosses are highly significant for the general combining ability and significant for the specific combining ability. As the former is higher than the latter, the level of resistance of any determined cross can be rather well appreciated by the $\hat{gi}$ of the parental clones. There is no significant difference between the phenotypic value of the clones and their cross value. Owing to the higher reproductive rate of the aphids in the crosses between clones compared to the parental clones, it seems that, in our experiment the pea aphid resistance is determined by recessive genes which is contrary to the results obtained in North America (1 dominant gene).

	Res.	12	58	T.	E.	La.
Res.	78.5	59.4	61.8	87.4	72.2	69.7
12		29.1	50.4	45.0	79.0	60.4
58			44.8	92.7	32.2	55.5
T.				65.7	56.6	8.6
E.					48.8	27.7
La.						11.2

Table 1. Net reproductive rate of the pea aphid bred on the clones of lucerne and their crosses (observed data)

RESISTANCE TO THREE SPECIES OF APHIDS IN WILD RELATIVES OF THE FABA BEAN (GENUS VICIA); TAXONOMIC PATTERNS AND POSSIBLE MECHANISMS.

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Partial resistance to aphids has been detected in a small number of Vicia faba cultivars. The probability of encountering a wider range of genetically-inherited resistance characters is greatly increased by screening crop progenitors and wild relatives; V. narbonensis (a close relative of V. faba) has been shown to be relatively resistant to Aphis fabae Scop. compared to the Faba bean. Attempts to introduce agronomically-useful characters to V. faba through inter-specific hybrids with wild Vicia spp. (vetches) have so far been unsuccessful, but may be achieved using somatic hybridisation.

The aims of this work were not to directly select wild Vicia species for hybridisation or crop development, but rather to identify taxonomic areas within the genus worthy of further study. The work describes taxonomic patterns of resistance within the genus to Aphis fabae Scop., Acyrthosiphon pisum Harris and Megoura viciae Buckton. In addition, individual components of aphid population growth are assessed in relation to possible mechanisms of antibiosis.

Twenty-nine wild Vicia species were taxonomically selected from available seed collections to give maximum coverage of infrageneric sections, and where possible, up to 4 Vicia species from larger sections. The 3 aphid species were selected on the basis of pest status and host range. Two feeding sites were assessed on each host (young leaflets and stem internodes) using 30 clonal apterae per site. Aphid performance was assessed under controlled laboratory conditions and quantified using the population growth index r_m (intrinsic rate of natural increase) and its components (survival, development rate, fecundity). Adult fecundity was only monitored for 10 days, subsequent reproduction contributing less than 5% of overall r_m values. Three possible mechanisms of antibiosis were assessed: a) physical barriers to nymphal stylet penetration b) effects of high trichome densities at preferred feeding sites and c) free amino acid content (protein and non-protein) at each feeding site. Regression analyses were used to test for significant associations between physical or chemical factors and measured host resistance.

Results from the laboratory screen demonstrated a wide range of antibiosis to aphids in the genus, from partial to total resistance, the most susceptible wild Vicia species being equivalent to the most resistant cultivars of V. faba screened by other workers. The 29 hosts were divided into 4 groups on the basis of subgeneric position and life-span. These four taxonomic groupings (group 1 = perennials from both subgenera, group 2 = annuals from subgenus Vicilla, group 3 = most annuals from subgenus Vicia except those in group 4, group 4 = closest living relatives of V. faba from section Faba), were found to correlate well with broad divisions based on differences in r_m values, i.e. in general, aphid resistance decreased from hosts of group 1 (high resistance) to group 4 (partial resistance).

Clear differences in aphid performance within the genus were found for the 3 species tested. A. pisum proved to be the most successful aphid species, both in terms of highest potential population increase and widest host range. A. faba was less successful on a range of hosts within the genus and M. viciae was the most host-restricted. Site-related differences in performance for the 3 aphid species agreed with published settling and feeding preferences.

Analysis of the components of r_m revealed that low nymphal survival rate was the most important constraint on aphid performance on hosts of groups 1 and 2. Adult pre-reproductive period, which can be the major factor limiting aphid population growth on crop plants only became a limiting factor on the most susceptible wild Vicia species.

Observations of aphid feeding behaviour together with correlative studies indicated that at least 3 mechanisms of antibiosis may be operating. On several perennial Vicia species from group 1 (especially 'oroboid' types) early aphid instars died through starvation, without successful stylet penetration of cuticle barriers. This physical mechanism was effective against all 3 aphid species. In addition, on pubescent annual species high densities of simple, non-glandular trichomes on preferred feeding sites were correlated with host resistance to A. faba and M. viciae but not A. pisum.

(continued on page 38)

CURRENT U. S. RESEARCH ON VEGETABLE RESISTANCE TO INSECTS AND MITES

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An extensive effort is required for a successful breeding program on arthropod (insects and mites) resistance in vegetables. This paper deals with the applied aspects of developing arthropod resistant vegetables and is limited to muskmelon, potato, sweet potato and tomatoes.

Programs on arthropod resistance are initiated through the preliminary screening of large numbers of plants usually in unreplicated trials either under field, greenhouse, or laboratory environments. Possible sources for a survey of resistance are plant introduction germplasm repositories, local collections, and plants of related species. It is the responsibility of the entomologist to identify the arthropods involved, including a study of biological races or related species as a part of the problem. The entomologist must also manage insect populations in the field and laboratory to establish the maximum differences between resistant and susceptible plants and to determine the degrees of plant infestation and damage.

Selection from the preliminary screening are made relative to plant vigor, damage ratings and arthropod counts and subjected to replicated testing with the appropriate pests. This procedure insures that all plant entries are resistant.

The basic properties of the plant responsible for resistance can now be determined (antibiosis, nonpreference, tolerance). Indepth studies can be accomplished through the confinement of pest arthropods to excised or whole plants and by observing pest reproduction, duration of life cycle, survival and weights. A knowledge of the ultimate cause of resistance, although biologically important, may not be essential to the practical breeding of plant resistance.

Selected plants are hybridized to combine genes for resistance with desirable horticultural characters and the breeding methods employed are backcrossing, recurrent selection and mass selection. When inheritance is simple, backcrossing provides a precise and rapid way of incorporating the resistance into a usable form. However, when inheritance is polygenic recurrent selection and mass selection techniques are used. The breeding procedures incorporating arthropod resistance in this paper are: 1) Muskmelon, backcrossing and recurrent selection, 2) potato, recurrent selection; 3) sweet potatoes, recurrent selection and mass selection; 4) tomatoes, backcrossing. The study of the resistance of the released lines and cultivars is essential as it can determine their value as an insect control method.

Valuable arthropod resistances have been identified in muskmelon (to Aphis gossypii, Diabrotica spp., Diaphania nitidalis), potatoes (to Empoasca fabae, Epitrix cucumeris, E. hirtipennis, Leptinotarsa decemlineata, Macrosiphum euphorbiae, Myzus persicae, Tetranychus urticae), sweet potato (to Chaetocnema confinis, Conoderus spp., Diabrotica spp., Phyllophaga ephilida, Plectris aliena, Systena spp.), and tomato (to Circulifer tenellus, Drosophila melanogaster, E. hirtipennis, Heliothis zea L. decemlineata, Liriomyza sativae, M. euphorbiae, T. cinnabarinus, T. turkestani, T. urticae, Trialeurodes vaporariorum).

(continued from page 36)

The results of chemical analyses of leaf and stem material for free amino acids were used to calculate chemical indices. The predictive value of these indices in determining host susceptability to aphids was tested by measuring the degree of association between predicted aphid performance (based on amino acid chemistry) and actual performance (measured by r_m). For A. pisum only 24% of the variation in r_m was explained by total amino acid content, and non-protein amino acids (toxins and phagodeterrents to several insect species) did not significantly affect performance. A. fabae and M. viciae however appear to be significantly affected by the presence of non-protein amino acids, explaining up to 53% and 40% of variation in host resistance respectively. Since these compounds were detected at very low concentrations in vegetative tissue compared to Vicia seeds, it is unlikely they act as direct toxins; it is more likely they are antifeedants which interfere with the control of normal feeding, following successful stylet penetration.

RESISTANCE TO THE TOBACCO WHITEFLY, BEMISIA TABACI, IN TOMATO AND RELATED SPECIES: A QUICK SCREENING METHOD

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The tobacco whitefly *Bemisia tabaci* Gennad., is a notorious pest of many agricultural crops. In Israel it is one of the most harmful pests of tomatoes (BERLINGER *et al.*, 1983a). The importance of breeding tomatoes resistant to the greenhouse whitefly (*e.g.* DePONTI *et al.*,1975) and to the tobacco whitefly (BERLINGER *et al.*,1983b) has been stressed.

In a previous set of field and laboratory experiments (BERLINGER *et al.*,1983b) some accessions of *Lycopersicon hirsutum f. glabratum* and of *Solanum pennellii* were found to be resistant to the tobacco whitefly. GENTILE *et al.*,(1968) suggested that the resitance in *Lycopersicon* and *Solanum* to greenhouse whiteflies is due to the stickiness of their leaves. DAHAN (unpublished data) proved that the sticky exudate of *Solanum* is the only mechanism of its resistance to the tobacco whitefly, sice leaves from which the sticky material was removed, became as susceptible as the control. The machnism of resistance to the tobacco whitefly in *L. hirsutum* f.*glabratum* is most likely also due to the sticky exudate of the leaves (SHEVACH-URKIN, unpublished data)

The success of a breeding programme for resistance to insects in plants is highly dependent on the availability of quick and reliable testing methods. With this in mind, an attempt was made to use the phenomenon of leaf-stickiness as a measure for resistance in the first step of plant screening. This measure, if reliable, will provide a quick mass screening method.

The guideline in the present work was first to find a correlation between resistance in *L. hirsutum* f.*glabratum* and *S. pennellii* and stickiness. The second step was to verify the result by testing another set of plants, F_2 hybrids (tomato x *S. pennellii*), for their stickiness and correlate it back to their resistance as expressed in a bioassay. Resistance was identified in terms of adult mortality rate. Four or ten adult females of unknown age were confined by means of a clip-on cage onto the underside of the examined leaf. After 24 hours the dead whiteflies were counted. The mortality rate was calculated and corrected in relation to the control (0% martality). Each experi-

*Part of M.Sc Thesis, the publication in full is in preparation

ment was conducted in 2-6 replicates. The leaf stickiness was determined as percent sucrose in an aqueous solution (see PLAGE, 1975). Granulated sucrose was scattered upon a known area of the leaf and the surplus was carefully shaken off. The sucrose which remained sticking on the leaf was washed off with a measured quantity of water. The sucrose content of the water was then measured by means of a refractometer.

In *L. hirsutum* f.*glabratum* the increase of resistance from 14 to 85% was accompanied by a parallel increase in the stickiness from 0.6 to 5.6%. Even the stickiest plants were not complete resistant. This relative resistance above 50% mortality, started when stickiness reached 2.1% sucrose. It was concluded that plants in the category of 20% stickiness or less, are too susceptible to be included in the breeding programme. Whereas plants, possesing a stickiness of 2.1% or higher, must be tested again by a bioassay. In *S.pennellii* - the susceptible plants possessed a stickiness of 0.8-1.0% at most. Relative resistance, above 50% mortality, was achieved at a stickiness of 2.0% whereas absolute resistance (100% mortality) was found whenever the stickiness was 2.2% or more. In the second step, F_2 hybrid plants were first classified as to their stickiness into three categories: 1.0% or less (susceptible), 1.2-1.8% (relative resistance) and 2.0% ormore (absolute resistance). The bioassay for resistance confirmed the suggestion that stickiness would be a useful criterion in preliminary screening.

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FECUNDITY AND SURVIVAL OF TRIALEURODES VAPORARIORUM WESTWOOD ON DIFFERENT EGG-PLANT VARIETIES

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Among the vegetables, the egg-plant Solanum melongena L. seems to be the most suitable host plant for the greenhouse white fly, Trialeurodes vaporariorum WESTWOOD (WOETS et al., 1976).

Our observations show differences between varieties in attractivity and multiplication of the pest in glasshouses (SICARD, 1981). The aim of the present study is to analyse in the laboratory, the main components of the rate of increase of the white-fly : fecundity, longevity of adults, length of life cycle and larval mortality.

Four egg-plant varieties morphologically very different from each other and originating from various geographical regions have been use' :

- Pusa purple cluster (PPC)..... } Tropical origin
- Monstrueuse de New-York (MNY)..... }
- Dourga (D)..... Mediterranean origin
- Ronde de Valence (RDV)..... Far Est origin

Laboratory tests have been made on young egg-plants (5 to 8 leaves), isolated in individual cages under controlled conditions (T = 22°C ; H.R. = 70-80 % ; 12L/12 D). Differences between varieties appeared for only some components of the rate of increase. Differences exist in daily fecundity but not in total fecundity (Table 1). So, the length of the egg-laying period is affected. The highest total fecundity that we have found is almost double than those observed by DI PIETRO (1977) because of longer female longevity and laying period.

In all varieties, longevity is higher in females than in males. As to the length of life cycle (from egg laying to adult emergence), there is a clear-cut difference between MNY and the three other varieties (Table 1). The difference does not seem to be more important in any particular larval instar.

The differences between varieties are most important in preimaginal mortality, chiefly on the eggs and the two first larval instars. The highest mortality rate is observed on the variety on which the duration of insect life cycle is the longest (RDV).

Multiplication of total fecundity per female by larval mortality rate allows to estimate the number of adults per female on each variety in the next generation (Table 1). This points out some antibiosis in the varieties Dourga and Ronde de Valence.

Finally, a high preimaginal mortality, specially on young instars is the main reason of the reduction of the increase rate of the white fly on some cultivars. Intervarietal differences observed in laboratory conditions and on young plants are coherent with the observations on older plants in glasshouses (SICARD, 1981).

Thus, differences between varieties do exist on egg-plant and they are of interest for varietal resistance selection against greenhouse white fly ; but we already know that the expression of resistance is often dependent of environment conditions and only the genetical intervarietal variability studied (MALAUSA et DAUNAY, 1982) will be utilizable.

Only antibiosis has been studied in this work, but we have also observed (SICARD, 1981) varietal differences in the attractivity of adults. These two factors of resistance which are not always associated in the same variety, are of prime importance in egg-plant selection against the greehouse white fly.

TABLE 1 : Life-table date of greenhouse whitefly on four egg-plant varieties

	RDV	PPC	D	MNY
Total fecundity (eggs).....	687	678	667	643
Daily fecundity (eggs).....	12,1	10,6	9,8	9,1
Female longevity (days).....	58,8	72,2	71,2	75,9
Male longevity (days).....	25,7	47,5	35,4	22,7
Preimaginal development (days).....	28,7	27,9	28,1	26,9
Preimaginal mortality (%).....	39,5	23,6	37,5	16,2
Estimation of female offspring (adults/female).....	416	518	417	538

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RECENT DEVELOPMENTS OF RESISTANCE TO GLASSHOUSE WHITEFLY IN TOMATO AND TO TWOSPOTTED SPIDER MITE IN CUCUMBER

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1. Tomato-glasshouse whitefly (Trialeurodes vaporariorum)

Resistance to the glasshouse whitefly has successfully been transferred from the wild species Lycopersicon hirsutum glabratum to the cultivated tomato. In 1982 some lines derived from a first backcross were selected, which combine a high level of partial resistance with a reasonable horticultural value.

The selection was based on a glasshouse test, where the population development of the whitefly was recorded. For isolation only one line was planted per glasshouse compartment. Per plant 15 females were released and the population development was sampled by counting the number of empty pupae on the most distal pair of leaflets. The number of adult whiteflies was also estimated on a linear scale of 0 to 9.

Table 1 shows that after about one generation of the whitefly the reproduction on the most resistant backcross lines is only one third to half of that on a susceptible standard variety, which was also the backcross parent. From earlier experiments we know that these differences increase in the following generations of the whitefly.

Our Solanum pennellii program has been stopped, because the resistance appears to be closely related to the presence of sticky glandular hairs. Such a mechanism is incompatible with biological control, because the parasitic wasps are also trapped.

Table 1. Differences in resistance as measured by counted numbers of empty pupae and estimated numbers of adults on a scale of 0 to 9, 6 weeks after inoculation.

Material	Empty pupae	Adults
cv 'Allround'	290	8
L. hirs. glabratum	129	2
80355 backcross line	92	1
81130 "	101	3
81132 "	121	4

2. Cucumber - twospotted spider mite (Tetranychus urticae)

Since the last meeting we have continued our efforts to transfer spider mite resistance to non-bitter cucumbers. This was based on our hypothesis, that there is no causal relation between resistance and bitterness, but only a genetic relation in terms of linkage between genes for resistance and bitterness. Selection was mainly carried out in the glasshouse, where the linkage was more obvious than in the laboratory. We succeeded to select some non-bitter lines, whose resistance approached that of their bitter parents. These lines have been released to Dutch breeding companies and we were close to finish the program.

During my stay in the USA some of the bitter and non-bitter resistant lines were tested in North Carolina in a field with a high natural population of T. urticae. The conditions were extremely hot, windy and dry. The resistance of the bitter lines was confirmed, but the non-bitter lines showed hardly any resistance. This difference between the Netherlands and the USA is alarming and requires further research into the relation between resistance and bitterness.

Our attempts to promote the biological control of glasshouse whiteflies on cucumber by breeding glabrous varieties have somewhat been changed, because of the adverse qualities connected with glabrousness. Therefore we study now F_1 hybrids of glabrous and hairy cucumbers carrying half the number of hairs.

Table 2. Comparison of two glasshouse tests in the Netherlands and a field test in North Carolina (USA) for resistance of cucumber to T.urticae. Only the final observation is listed. Damage ratings are recorded on a scale of 0 (no damage) to 5 (maximal damage).

Material	Bitterness	Damage Rating		
		The Netherlands		USA
		1981	1982	1982
G6	-	3.8 a	4.1 a	3.9 a
F_6 (H x R)	+	1.6 b	2.0 b	0.5 c
F_5 (H x V)	+	1.5 b	1.6 b	0.3 c
F_5 (G6 x F_5(H x V)	-	1.9 b	1.9 b	3.3 a
F_3 (G6 x F_3(H x V x H x R)	-	1.8 b	2.5 b	3.9 a

CHEMICAL ASPECTS OF VARIETAL RESISTANCE OF CARROT TO THE CARROT FLY, PSILA ROSAE (F.)

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Field experiments were made to investigate the resistance of several varieties of carrot, Daucus carota, to the carrot fly, Psila rosae (F.). Observations were made on numbers of eggs, larvae and damaged roots. Significant differences in resistance were detected between some varieties and these seemed to result from differences in numbers of eggs laid and, independently, numbers of larvae established in the root.

The behaviour of the carrot fly larva in the presence of some root volatiles has been described indicating the presence of repellent and attractant compounds (1,2). The sensory receptors mediating the perception of such compounds have also been described (3). We have compared resistant and susceptible varieties in terms of compounds extractable from roots and their possible relevance to resistance will be discussed.

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PROGRESS IN THE STUDIES OF RESISTANCE TO CARROT FLY (Psila rosae) IN CARROTS

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INTRODUCTION

Studies of resistance to carrot fly (Psila rosae F.) in carrots (Daucus carota L.) began at Wellesbourne in 1970. Progress in this project where plant breeders and entomologists have collaborated is summarised in this paper.

HOST RANGE OF CARROT FLY

More information on the host range of the carrot fly may help to identify new sources of resistance to the pest. Resistant close relatives of carrot may be of value in breeding programmes. The results of evaluating 27 umbelliferous species as hosts were published earlier (Hardman & Ellis, 1982). Three of the 27 species tested, Anthriscus sylvestris (L.) Hoffm., Ferula communis L. and Smyrnium olusatrum L. failed to support carrot fly and 13 species were new host records. Two species, Chaerophyllum temulentum L. and Torilis japonica (Houtt) DC which are numerous and widespread wild flowers in carrot-growing districts, supported large numbers of carrot fly. Very few carrot flies were supported by plants of Daucus capillifolius Gilli and D. glochidiatus (Labill.) Fisch. Mey. et Ave-Lall indicating that these may be useful in future breeding programmes and crosses have been made between D. capillifolius and cultivated carrots. In 1982 a further 17 species of umbellifers were tested and collection of the results will be completed in 1983.

SCREENING OF CARROT CULTIVARS

More than 200 carrot cultivars collected world-wide have been screened for resistance to carrot fly in the field. Approximately twelve of these cultivars have been shown to be consistently less damaged than the rest. This partial resistance has been investigated in cv. 'Sytan' and is largely due to antibiosis - fewer larvae establish and the larvae take longer to develop on this resistant host. Under the auspices of the IOBC Carrot Fly Project Group, 8 carrot cultivars representing the range of resistance to carrot fly discovered in England were grown at 12 sites in 5 European

countries in 1977 and 1978. The relative resistances of the 8 cultivars were the same as in England and no evidence of biological races of carrot fly was discovered.

SELECTION AND BREEDING

Attempts are being made to increase the levels of partial resistance discovered in certain cultivars by selection. Four cycles of selection for resistance in the cultivar 'Long Chantenay' led to a small shift in the resistance in early generations. However, the interpretation of the results of testing more advanced generations has been complicated by great variability in the performance of individual seed stocks in different trials. The influence of plant density on the resistance of these and other breeding lines is being investigated. A programme of selection within the partially-resistant cultivar 'Sytan' began in both The Netherlands and England in 1980. Through an exchange of material between countries it is planned to compare the effectiveness of different selection methods.

Crosses have been made between the partially-resistant cultivar 'Sytan' and representatives of the three major UK carrot groups, Chantenay, Autumn King and Berlicum to provide material for breeding programmes.

A single seed descent programme was begun in August 1981 to develop carrot inbreds with a range of resistance to carrot fly. This programme is based on an F_2 family resulting from a 'Sytan' x 'Long Chantenay' cross. A twelve month seed-cycle of inbreeding can be achieved in a glasshouse by regulating environmental conditions.

INTEGRATED CONTROL OF CARROT FLY

Field experiments have investigated whether the use of insecticides and partial resistance are complementary in their action. Trials over three seasons compared the performance of log dose treatments of three insecticides applied to cultivars representing the extremes of the range of resistance. The results showed that approximately one third of the dose of insecticide was required to provide effective control of carrot fly on the resistant cultivar 'Sytan' as compared with the highly susceptible 'Danvers Half Long 126'. These results suggested that partial resistance and insecticides were complementary in their action against carrot fly.

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PRELIMINARY ENTOMOLOGIST'S AND PLANT BREEDER'S RESULTS ON SEARCHING FOR CAULIFLOWER RESISTANT TO CABBAGE ROOT FLY, *Delia radicum (brassicae)* L.

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The outbreak of insect pests on cruciferous plants is made easier by the great number and diversity of cultivated crops of this family.

Investigations have been made on the non-preference resistance type of 14 cultivars of cauliflower *(Brassica oleracea* var. *botrytis)* to the cabbage root fly, *Delia radicum (brassicae)* L., in order to find a way of reducing chemical treatments against this pest. The cultivars were: Saxa, Selandia, Succès, Weslandia, Idol, Grandesse, F1 Coronado, Perfection, Opaal, Panda, Fortados, Nevada, Brendo and Imperator. This work requires a parallelism between the development of the crop and that of the insect and implies a study of progenies of attractive and non-attractive plants. There are possibilities of selection among the cultivars since 13 of 14 mentioned above are open pollinisators, the type of these plants being both autogameous and allogameous.

The relative level of resistance of the plants was determined by counting the eggs laid on the stem of the plant. The cultivars were field-grown in experimental plots and exposed to a naturally occurring fly population.

An egg trap was worked out in order to facilitate egg counting on a great number of individual plants.

The fly population proved to be sufficiently high to reveal genetic variations among the plants without compromising their survival.

When egg counts of the different cultivars are plotted on a graph, one realizes that the figures are so much alike that the egg counts can be limited to the period between the middle of July and the middle of August covering 68% to 92% of the total egg mass laid during the growing period.

The most attractive cultivar (F1 Coronado) received 1.6 and 3.6 times more eggs than the least attractive (Panda). However, the differences, significant between cultivars, are even more strikingly significant between individual plants within a cultivar. Therefore, selection should be operated by setting up inbred lines from non-attractive individual plants of proven

commercial value.

Different factors, however, linked with plant characters, made it difficult to obtain progenies. It is thought, therefore, that the risk of losing promising parents could be diminished by cultivating plant tissues in vitro.

EFFECT OF RESISTANCE TO MYZUS PERSICAE IN LACTUCA ON APHID POPULATION DEVELOPMENT UNDER CONTROLLED AND FIELD CONDITIONS

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Significant and consistent differences for resistance to M.persicae were found in tests under distinct environmental conditions. The resistance was always higher to biotype WM_2 than to biotype WM_1. It was the resultant of various components (EENINK & DIELEMAN, 1982 a).

In several laboratory tests the effect of such components on the resistance level was investigated. Table 1 shows some of the results with clear differences between lettuce cultivars for components like mortality of larvae, larval period, larvae production and adult mortality.

Table 1. Differences between lettuce cultivars for components of resistance after infestation with two biotypes (WM_1, WM_2).
- = partially resistant, + = susceptible

Cultivar	larval mortality (%)		larval period (days)		larvae production (in 10 days)		adult mortality (%)	
	WM_1	WM_2	WM_1	WM_2	WM_1	WM_2	WM_1	WM_2
PIVT 47(-)	47	90	8.4	12.0	19	1	53	100
PIVT 313(+)	41	56	7.9	8.7	32	14	40	54

Based on the various components of resistance a stochastic simulation population model was made. Sensitivity analyses revealed that already a slight change of one of these components, such as larval period, greatly influenced population development.

The ultimate effect of components for resistance on the growth rate of biotype WM_1 is indicated in Table 2. The table shows results of tests under controlled conditions where different numbers of aphids per plant were applied at the time of infestation. Large and consistent differences for resistance

level occurred between lettuce genotypes.

Table 2. Number of aphids per plant 14 days after inoculation with 10, 20, 30 or 40 L_3 larvae of biotype WM_1.

Lettuce genotype	Number of aphids per plant			
	initial larvae density			
	10	20	30	40
PIVT 47 (-)	202	427	452	494
PIVT 619 (-)	540	708	631	561
PIVT 313 (+)	1632	3108	3318	5333

Similar results were found after testing partially resistant and susceptible lettuce genotypes in the field after natural infestation shown in Table 3 (EENINK & DIELEMAN, 1982 b).

Table 3. Number of aphids per plant after natural infestation in field experiments in 1981 and 1982.

Genotype	Aphids per plant			
	1981		1982	
	23/7	18/8	20/7	26/7
PIVT 47 (-)	66	59	91	122
PIVT 180 (-)	53	144	102	118
IVT line (-)	-	-	47	34
Mondian (+)	23	481	-	-
PIVT 313 (+)	-	-	123	>500

Genetic recombination of resistance genes after crossing partially resistant genotypes resulted in an accumulation of such genes. Table 3 shows an increase of resistance of the IVT line compared to partially resistant progenitors. Resistant lines will soon be released for transfer of resistance to standard lettuce cultivars.

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GENES FOR PARTIAL AND COMPLETE RESISTANCE OF LACTUCA TO NASONOVIA RIBS-NIGRI

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Near complete resistance (CR) to the leaf aphid Nasonovia ribis-nigri has been transferred from an accession of the wild species L.virosa to L.sativa through interspecific crosses (EENINK et al., 1982 a).In the L.sativa genome this resistance appeared to be governed by one dominant gene (EENINK et al., 1982 b).

As several sources of L.virosa with CR were found (EENINK & DIELEMAN 1982 a) it should be known whether these accessions, originating from different plant ecosystems, contain the same resistance genes.

Intercrossing six CR accessions and one partially resistant (PR) accession of L.virosa revealed that CR was based on one dominant gene designated as Nr while PR was governed by the recessive allele nr. All alleles, both for CR, PR and for susceptibility (S) were present at the same locus (EENINK & DIELEMAN, 1983 in preparation). This implies that the genetic base of the CR exploited so far in lettuce breeding, is extremely narrow.

Partial resistance has both been found in L.virosa, as mentioned before, and in L.sativa. In L.virosa this PR is governed by the gene nr in PIVT 273 and by minor genes. These minor genes apparantly strengthen or support the effect of the Nr gene for CR. Namely after transfer of the Nr gene from L.virosa to L.sativa the level of CR in L.sativa had been slightly decreased (Table 1).We ascribed this loss of resistance to a loss of minor genes (EENINK & DIELEMAN, 1982 b).

Table 1. Mean daily larvae production per apterous adult on CR, PR and S genotypes

IVT line	Larvae production per day per adult			
	L.sativa (CR)	L.virosa progenitor(CR)	L.virosa (PR)	L.sativa c.v.Taiwan(S)
	0.49	0.30	2.32	3.00

Partial resistance in L.sativa cultivars appeared both in field experiments and after retesting in laboratory tests (Tables 2 and 3).

Table 2. Number of aphids per plant of four lettuce genotypes in a field test in 1981 after natural infestation.

Genotype	Aphids per plant		
	15/6	22/6	30/6
IVT line (CR)	7	19	12
PIVT 47 (PR)	26	165	300
PIVT 180 (PR)	24	109	288
c.v. Mondian (S)	27	193	538

Table 3. Larvae production per adult on three lettuce genotypes in 5 days in a laboratory test.

Larvae production per adult in five days		
PIVT 47 (PR)	PIVT 180 (PR)	c.v. Suzan (S)
21.5 (69%)	22.5 (73%)	31.0 (100%)

These genes for partial resistance in L.sativa should be exploited in resistance breeding to increase the level of CR and possibly to enforce durability of resistance.

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EFFICIENCY OF THE RESISTANCE TO APHIS GOSSYPII IN MUSKMELON. FIRST RESULTS OBTAINED IN CONTROLLED AND NATURAL CONDITIONS

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The Melon aphid, **Aphis gossypii** Glov., causes severe deformations on leaves of muskmelon (**Cucumis melo** L.) plants. It is also a very efficient vector of several virus diseases of this crop. A complex resistance to **A. gossypii** has been found in some Melon lines including P.I. 161375 (SC). Although it has a simple inheritance (one dominant allele :Vat), it gives together a resistance to **A. gossypii** by non acceptance and by antibiosis and it also prevents virus transmission by this aphid (LECOQ et al 1979, PITRAT et LECOQ 1980, 1982).

The potential interest of this resistance incited the development of a breeding program to introduce it within varieties cultivated in France. In the same time, a study was started to assess the durability of the resistance and its efficiency in the field. The first results obtained are reported here.

In a first step, the resistance of SC was checked with six clones of **A. gossypii** from different geographical origins. Whatever was the component examined (non acceptance, antibiosis or virus transmission), SC was found resistant while the control cultivar "Doublon" was susceptible. However some differences were noticed in the multiplication rates of these clones on the susceptible cultivar.

In a second step, an **A. gossypii** clone was maintained during several generations on SC older leaves - where some larvae are produced - in order to check whether this could induce the selection of a biotype able to break the resistance. After 15 generations on SC, this clone was unable to overcome the three components of the resistance (non acceptance, antibiosis and virus transmission).

In the field, the resistance to A. gossypii has three major effects :

- it reduces the A. gossypii populations (alatae, apterous adults or larvae) on the plants in comparison with susceptible controls;

- it prevents leaf curling;

- it slightly delays the virus epidemic (2 to 4 days according to the epidemiological conditions). Virus epidemics are not completely prevented because several other aphid species play an important role in the virus spread and the resistance to virus transmission is only efficient towards Aphis gossypii (LECOQ et al 1980).

Although A. gossypii resistant cultivars were grown in large experimental plots for six successive cultures, no resistance-breaking biotype has been observed in the field. This and the good behaviour of SC towards six A. gossypii clones from different origins suggest that the resistance will be durable.

The genetic resistance of Melon to A. gossypii is very efficient in protecting the crop against the development of aphid infestations. However, it is not sufficient to provide a good protection against stylet-borne viral diseases. This resistance should therefore be completed either by adapted cultural practices (such as plastic mulches) or by genetic resistances to the viruses themselves (LECOQ & PITRAT 1983).

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EVALUATION DE LA RESISTANCE AU PHYLLOXERA DES HYBRIDES *Vitis vinifera* x *Muscadinia rotundifolia* AU MOYEN DE TESTS DE CONTAMINATION "in vitro" SUR RACINES ISOLEES.

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Le Phylloxéra de la Vigne (*Phylloxera vastatrix* PLANCHON) est probablement l'un des pucerons les plus connus du fait de sa responsabilité dans la destruction des vignobles européens à la fin du XIXe siècle. Depuis cette époque, la permanence de l'insecte dans la quasi-totalité des terroirs viticoles français, rend obligatoire le greffage des cépages traditionnels de l'espèce *Vitis vinifera* L., sur des porte-greffes issus d'espèces américaines résistantes. Néanmoins cette résistance n'est pas totale : les porte-greffes hébergent le plus souvent sur leurs racines des populations plus ou moins importantes de radicicoles et certains d'entre eux présentent dans les champs de pieds-mères une sensibilité particulière du feuillage à la forme gallicole de l'insecte.

L'espèce *Muscadinia rotundifolia* (MICHX) SMALL, cultivée sous le nom de vigne "muscadine" sur quelques milliers d'hectares dans le Sud-Est des Etats-Unis, est connue depuis longtemps pour sa résistance totale au Phylloxéra (RAVAZ, 1902). Malheureusement, elle n'est pas utilisable dans la pratique comme porte-greffe en raison de son inaptitude au bouturage et de son incompatibilité au greffage avec les cépages européens. D'autre part, ses possibilités d'utilisation en croisement ont longtemps été considérées comme illusoires, du fait de l'éloignement génétique des genres *Vitis* et *Muscadinia*.

Des travaux récents (BOUBALS et PISTRE, 1978 ; BOUQUET, 1981) ont montré que cette espèce est également résistante au nématode *Xiphinema index* THORNE et ALLEN, vecteur du court-noué, principale maladie à virus de la Vigne (grape fanleaf virus). Nous avons donc entrepris de l'utiliser comme géniteur de résistance dans un programme d'hybridation intergénérique visant à créer de nouvelles variétés de porte-greffes permettant l'éradication des deux principaux parasites animaux de la vigne.

En vue d'apprécier d'une manière précoce et rapide le niveau de résistance des génotypes hybrides au Phylloxéra radicicole, nous avons utilisé une méthode de contamination "in vitro" (POUGET, 1975), donnant des résultats en parfaite corrélation avec les résultats de tests en serre ou d'essais au vignoble ; Des racines agées d'un an sont prélevées sur des plants de semis hybrides cultivés en hydroponique sous serre. Après un lavage soigneux, des

fragments de racines de 1 à 2 mm de diamètre et de 5 à 8 cm de long sont disposés dans des boites de Pétri sur du papier buvard humide, inoculés au moyen de galles phylloxériques foliaires et maintenus à 25°C à l'obscurité. Au bout de 3 à 4 semaines, les racines sont examinées à la loupe binoculaire (X 20) : il est alors possible de distinguer, d'après la nature et l'intensité des symptômes, et le nombre de colonies fixées sur les racines, cinq classesallant de la résistance totale (notée "0") à l'extrême sensibilité (notée "4"). La résistance totale, caractéristique des variétés de l'espèce *M. rotundifolia* s'apparente à une non-réceptivité. Les nécroses aux points de piqûres sont très limitées. Il n'y a aucune formation de nodosités sur des radicelles ou de tubérosités sur les troncs radiculaires. Les Phylloxéras, incapables de se fixer et de se reproduire sur les racines meurent rapidement.

L'application du test à 591 hybrides F_1 *V. vinifera* x *M. rotundifolia* fait apparaître une distribution nettement bimodale des descendances en fonction du caractère de résistance : les plantes sont en majorité notées "0" et "3" ou "4". La proportion d'hybrides notés "0" est de 51,6 % sur l'ensemble des descendances F_1, mais elle varie de 39,7 à 65,3 % en fonction de la variété *M. rotundifolia* utilisée comme parent mâle.

En revanche, la proportion d'individus notés "0" dans les descendances R_1 obtenues par rétrocroisement d'hybrides F_1 résistants (pollinisateur : *V. vinifera*) est inférieure à 20 %, la majorité des plantes étant notée "4".

En fonction de ces résultats, il est possible d'envisager un déterminisme génétique relativement complexe dans lequel l'expression d'un gène semi-dominant de résistance au Phylloxéra ($R\psi$), à l'état homozygote chez *M. rotundifolia*, serait modulée chez les hybrides F_1 par plusieurs gènes modificateurs M_1, M_2, M_3, M_4 présents à l'état hétérozygote ou homozygote chez les variétés de muscadines.

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A RAPID ASSAY OF VARIETAL SUSCEPTIBILITY TO HOPPERBURN IN GRAPE (VITIS VINIFERA) CAUSED BY LEAFHOPPER *EMPOASCA VITIS* GOETHE

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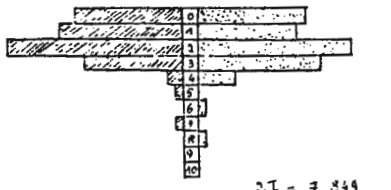
Feeding by the leafhopper, *Empoasca vitis* Goëthe, causes a marginal drying and necrosis (hopperburn) to leaves. We compared a rapid visual system of rating the extent of hopperburn to precise measurements using an electronic coordinate reader. Our rating scale of hopperburn as a percentage of total leaf area was related to the probit scale, which takes into account the greater facility of the human eye to discriminate the two extremes of such a scale. Our scale was as follows :

Hopperburn scale	0	1	2	3	4	5	6	7	8	9
Percentage of hopperburn	0	2	5	15	30	50	70	25	95	97.5

The healthy potted grapevines for each of 8 varietes were grown in caged form 2 - node cuttings in the greenhouse. At the stage when the plants had 7 mature leaves, 20 adults *E. vitis* were caged on them for 15 days. The plants thereafter kept in cages another 15 days. We then evaluated the extent of hopperburn on each plant, first using our visual rating scale in the greenhouse. Immediately after, tracings of each leaf and the area of hopperburn were made on translucent paper and the actual area were measured on an electronic coordinate reader (Hewlett - Packard N° 9810).

The correlation between visual ratings and precise measurements of hopperburn was higly significant ; the non - parametric 2 I test failed to show any significant difference between the frequency distributions of hopperburn in each variety. Thus, the visual ratings gave accurate estimates of the extent of hopperburn. Moreover these was a significant heterogeneity $p > 0{,}001$ among the hopperburn measurements of the varieties, which indicated varietal differences in susceptibility to damage by feeding of *Empoasca vitis* Goethe.



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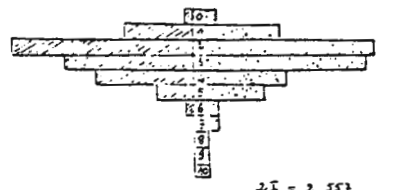

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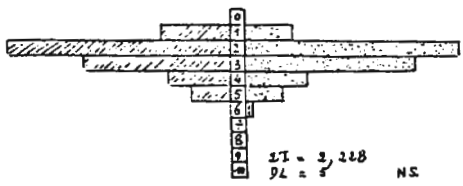

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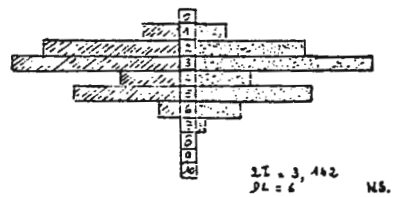

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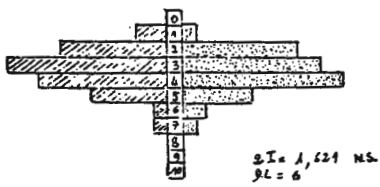

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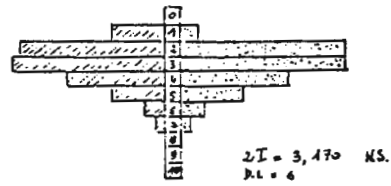

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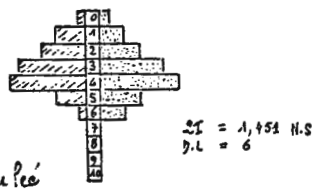

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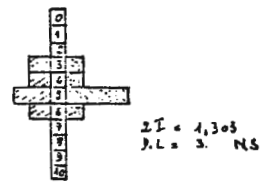

Morrastel

Comparison between the visual ratings and those of precise measurements in relation to the percentage of total leaves area.

RAPE SELECTION AND ENTOMOLOGICAL PROBLEMS

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All plants of the Crucifer family contain sulfurous substances, the glucosinolates, which by enzymatic degradation yield secondary compounds. Among those the isothiocyanates (volatile or not) present a great entomological interest. The influence of these products on different behavioural phases of insects associated with Crucifers has been studied for many years. Their defensive role against polyphagous insects has also been studied more recently. Then, the selection of new rape varieties with low glucosinolate content for a better valorization of rape oil-cake might have entomological consequences : an polyphagous insectes more agressive toward the new varieties, would insects pests usually present on rape have their reproduction rate modified by lack of the right stimuli ?

The preliminary experiments reported here try to answer part of these questions.

1. Table 1 summarise the results of the experiments made for three years on the seed-pod weevil, *Ceuthorrhynchus assimilis* Payk.

Table 1. Contamination of several varieties. Results per plant.

Year	Variety	Glucosinolates	Nutricial punctures	Number of larvas	Weight of larvas (mg)
80	Romeo	+	4.8	2.2	
	Bronowsky	-	4.8	2.7	
81	Jet neuf	+	30.5	4.3	3.13
	JN-404	-	30.0	3.8	3.40
82	Jet neuf	+		3.7	
	JN-404	-		2.0	
	D-380	-		7.9*	

* significant difference

The glucosinolate content is showed by a + in normal varieties and a - in low content ones. In the experiments of 80 and 82 the insects had the choice between the varieties but not in 81 which enabled us to control the weight of the larvas at their exit from the pod. The number of larvas per plant is quite low in 80 due to a very late time for the experiment. In 81 and 82 it

is the heat in the glass house which inhibited egg - laying. There is no variety influence on the mesured variables except for the number of larvas on D-380 in 82. The variety, not of French origin, has not the same genetic background as the others. Flowering was longer and more heterogeneous on those plants and that could explain the significant result. A complementary choice experiment in 81 in outside condition gave more normal levels of egg laying which resulted in 55 larvas per plant in Jet neuf and 40 on JN-404. The difference is not significant.

2. The percentage of attacked plants (with larva) by the stem weevil *Ceuthorrhynchus napi* Gyll. was controlled on 3 m samples in a variety block trial. Significant differences between varieties can be seem in table 2.

Table 2. Analysis of attack by *C. napi* in a variety block trial.

Varieties	Jet neuf	D-180	D-280	JN-332	Kid	JN-404
Glucosinolates	+	-	-	-	+	-
Means (%)	40.6	35.5	33.3	32.8	29.4	28.0
ppds = 5,8						

There is a significant block effect (F = 17.46 ; d.f. : 3.15) and variety effect (F = 5.55 ; d.f. : 5.15).

The analysis of glucosinolates in seeds do not give any useful information to explain the result : Jet neuf and Kid have both a high glucosinolate content all the others having a low content. It is almost certain that differences in stem elongation of the varieties tested have an influence on the insect choice but the hypothesis of an interaction with chemical factors should not be excluded.

3. Preliminary results on the development of colonies of *Myzus persicae* Sulz., a polyphagous insect occasionnaly present on rape, showed a tendency toward a quicker growth (twice as fast) of these colonies on varieties with a low content of glucosinolates (in controlled conditions). These results will have to be confirmed.

The glucosinolate content of seeds in old varieties is only a little more than twofold that of new varieties and the relative proportions of the 4 molecules which can be analysed independently stay the same in both. The analysis of green part is not yet possible in this country. Anyhow it is probable that this lowering in the amount of glucosinolates is not enough to change reproduction in insects associated with rape but it may be enough to increase problems with polyphagous insects like the green peach aphid also present on this culture.

INFLUENCE DE QUELQUES SUBSTANCES ALLELOCHIMIQUES SUR LA PHYSIOLOGIE ALIMENTAIRE DES LARVES DU VER DE FARINE : *TENEBRIO MOLITOR* L.

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Pour mesurer, par voie biologique, l'efficacité nutritionnelle des plantes, on a recours à différentes méthodes pouvant faire intervenir aussi bien des microorganismes que des vertébrés (rats ou poulets).

Les résultats obtenus au laboratoire avec le ver de farine, *Tenebrio molitor* L. montrent que cet insecte peut être utilisé pour l'évaluation de la qualité nutritionnelle des plantes protéagineuses destinées à l'alimentation des monogastriques.

Parmi les essais effectués au laboratoire de Bordeaux, certains ont porté sur l'influence de substances antinutritionnelles sur la physiologie alimentaire des larves de *T.molitor*, estimée par le calcul de trois critères :

1 - La consommation de matière sèche des régimes en 28 jours d'essai :

$$QS_{mg/larve} = \frac{\text{M.S. d'aliment à Jo - M.S. d'aliments à J.28}}{\text{nombre de larves}}$$

2 - La croissance des larves estimée par le gain de poids sec pendant 28 jours d'esai :

$$\Delta PS_{mg/larve} = \frac{\text{Poids sec des larves à J.28 - Poids sec des larves à Jo}}{\text{nombre de larves}}$$

3 - L'indice de transformation de la matière sèche :

$$Is = QS / \Delta PS$$

C'est ainsi que l'on a mis en évidence l'influence du taux des saponines de la luzerne, des glucosinolates présents dans le tourteau de colza et des alcaloïdes du lupin sur les critères précédemment cités.

Quelques résultats sont présentés dans les tableaux suivants :

A - Effet des saponines de la luzerne :

Variétés	Saponines	ΔPS	QS	IS
LAHONTAN	-	8,47 a	60,53 a	7,15 a
RURO	+	3,08 b	28,79 b	9,35 b
EUROPE	++	1,23 c	22,11 c	17,98 c
ORCA	+++	0,75 d	13,53 d	18,04 c

B - Effet des glucosinolates du colza :

Variétés	Glucosinolates	QS	ΔPS	IS
REGENT	-	111,1 a	22,0 a	5,0 a
JET 9	+	84,7 b	12,9 b	6,6 b

C - Effet des alcaloïdes du lupin :

Variétés	Alcaloïdes	QS	ΔPS	IS
LUBLANC 813	-	94,47 a	18,09 a	5,22 a
LA 106	+	29,79 b	4,51 b	6,60 b

Une analyse de variance est effectuée. Les moyennes sont comparées par le test de DUNCAN et sont affectées de lettres différentes lorsqu'elles sont significativement différentes (au seuil de 1 %).

Les sources protéïques présentent le plus souvent des variabilités suffisamment importantes pour mettre en place des programmes de sélection de variétés à faible teneur en substances secondaires indésirables pour les monogastriques(poulets, porcs).

D'autre part, la technologie essaie de remédier aux inconvénients présentés par les sources protéiques végétales avec plus ou moins d'efficacité. Par exemple, la technique du décorticage permet d'abaisser la teneur en cellulose et en tanins des graines, les traitements thermiques inactivent les substances anti-nutritionnnelles de nature protéique (anti-trypsiques du pois).

Ce test biologique, à l'aide du ver de farine, permet d'estimer les améliorations apportées à la valeur nutritionnelle par la technologie et la sélection variétale et, simultanément, il donne un exemple de l'augmentation de la sensibilité de la plante améliorée aux attaques d'un ravageur polyphage.

RESISTANCE TO DYSAPHIS PLANTAGINEA IN APPLE. EFFECTS ON APHID BIOLOGY

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Dysaphis plantaginea, the rosy apple aphid, is the most serious aphid pest of apple in the U.K., causing damage to shoots, leaves and (particularly) fruit. Resistance to this pest is derived from the major gene Sm_h from Malus robusta and is readily determined by insectary screening, since a pronounced hypersensitive reaction appears in the plant in rapid response to aphid feeding. In general, survival and fecundity of aphids is substantially lowered on hypersensitive plants, final aphid size is reduced and instar interval lengthened. This resistance therefore appears to be a classic antibiosis. There is some evidence, e.g. from insectary tests at East Malling, that the resistance is not uniformly effective.

HERITABILITY IN PEACH OF THE HYPERSENSITIVITY REACTION TO THE GREEN PEACH APHID *MYZUS PERSICAE* Sulzer.

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The green Peach Aphid (GPA) is an important pest on Peach *Prunus persica* (L) Batsch (LECLANT et REMAUDIERE, 1970). Previous research has detected resistance to GPA in peach cultivars that have not been bred for fruit quality, notably the cultivar S 2678 (MASSONIE et *al.*, 1982). The sexual form of GPA colonize this cultivar but not the fundatrices nor the *fundatrigeniae*. *Fundatrigeniae apterae* artificielly placed on orchard or nursery trees or seedlings in the laboratory leave these plants quickly (within 3 days). Their feeding punctures produce an easily seen necrosis on seedlings or nursery plants. We have used this necrosis as a marker for studies of the heritability of the character of resistance to GPA.

Hybrids from crosses of the aphid susceptible "Redhaven" and the GPA resistant cultivar S 2678 were self pollinated. The progeny of these hybrids raised in a nursery for two years were artificially infested with GPA *fundatrigeniae apterae* during the month of may. The number of aphids remaining and the occurence of necrosis was assessed 2,4 and 6 days later.

Among a total of 75 plants, 21, (28 %) did not express the necrotic reaction. Four days after the contamination, the aphids left those plants that expressed the necrotic reaction to feeding by GPA. The results further confirm the association of the necrotic reaction to GPA feeding and resistance to GPA. They suggest that the necrotic reaction associated with GPA resistance is controlled by a single dominant gene.

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DIFFERENCES IN VARIETAL RESISTANCE TO THE TRANSMISSION OF PLUM POX VIRUS BY *MYZUS PERSICAE* Sulzer TO PEACH *PRUNUS PERSICA* (L) Batsch.

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INTRODUCTION

Plum pox is a viral disease of Prune, Peach and Apricot. The virus is non persistanly transmitted by Aphids (O.E.P.P., 1974). Experimental Aphid transmission to Peach seedlings, using virginopare green Peach Aphids (G.P.A.) *Myzus persicae* Sulz. was significantly less to two of three peach cultivars tested (MASSONIE et MAISON, 1980, 1982). The diagnosis of virus free plants was based on disease symptoms and negative serological E.L.I.S.A. tests (MAISON et *al.*, 1983). These two varieties were thus considered more resistant to Plum pox virus transmission by G.P.A. *virginoparae apterae* than standard cultivars. A common characteristic of cultivars resistant to Plum pox virus transmission by G.P.A. is their resistance to colonization by G.P.A. We have studied in Peach the relationships between resistance to GPA and resistance to Plum pox virus transmission by GPA

MATERIALS AND METHODS

Peach cultivars were selected according to their resistance to GPA.

GROUP A - CULTIVARS WITHOUT IMPROVED FRUIT CHARACTERS

A 1 - Two varieties with resistance to GPA as expressed by the rapid (72 hours) departure of GPA *fundatrigeniae apterae* after artificial contamination. This resistance is linked to a necrotic lesion formed around feeding punctures of the *fundatrigeniae apterae*. The *virginoparae* do not produce a visible necrosis by feeding.

A 2 - Four varieties on which GPA *fundatrigeniae apterae* gain very little weight, have much lower fecundity and produce mainly winged offspring.

A 3 - A cultivar susceptible to GPA

GROUP B - COMMERCIAL CULTIVARS

B 1 - A cultivar very susceptible to GPA

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B 2 - Two varieties considered less susceptible to aphids and Plum pox based on selections from a region in Greece heavily infested by Plum pox.

Inoculations were made either on young seedlings or new growth from grafted buds. The same rootstock variety and growing conditions were used for all test plants. An isolate of Plum pox virus that was severe in Peach (MARENAUD et MASSONIE, 1977) was used. The virus was Aphid transmitted using methods previously described (MASSONIE et MAISON, 1980).

RESULTS

Transmission to grafted scions of the same variety was erratic. However, the rate of transmission to plants of group A 1 was significantly less than transmission to any of the other groups. Therefore, resistance to transmission of Plum pox virus by GPA is linked to the resistance to GPA expressed by the varieties in this group.

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ROLE OF PHENOLICS IN THE RESISTANCE OF PEACH *PRUNUS PERSICA* (L) Batsch. TO THE APHID *MYZUS PERSICAE* Sulzer

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INTRODUCTION

Several phenolics are toxic or repulsive to aphids in synthetic diets and certain phenolics are involved in Plant resistance to Aphids. Studies of their role in Plant varietal resistance or on the alternation of Plant hosts by Aphids, particularly that of Peach to *M. persicae* are linked to the kinds and the concentration of phenols which increase during the season when *M. persicae* leaves Peach (POESSEL et *al.*, 1980).

MATERIALS AND METHODS

The work presented concerns two varieties of Peach : one susceptible (GF 305), the other resistant to *M. persicae* (S 2678). Aphid *fundatrigeniae apterae* placed on the resistant variety left within 72 hours, whereas Aphids readily colonized the susceptible variety. From may until july 1982, leaves were severed from the apical, subapical or basal part of newly-grown shoots fro mature trees. Aphids select shoot tips to larviposit. As shoots continue to grow, colonies remain on the same leaves, however Aphids do not remain on basal(mature) leaves. Phenolics were extracted with ethyl acetate (FLEURIET and MACHEIX, 1972) and incorporated into a basic synthetic diet (MASSONIE, 1980). Nymphs less than 24 hours old were placed on sachets containing (1) basic diet, or (2) a "blank" of water soluble fraction of extracting solvents, or (3) phenol extracts and the water soluble fraction of extracting solvents. After 7 days, the weight of insects from each treatment were compared by a non parametric test.

RESULTS

1 - Influence of variety and leaf age

All phenols containing diets provoked significant weight losses (> 30 %) by Aphids compared to the basic diet alone or to the "blank". There were no significant differences between weights from the basic diet and the "blank". The losses of weight caused by extracts from basal leaves were not significantly different from those caused by extracts from subapical leaves. On contrast, extracts from apical leaves from the resistant variety

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caused a greater weight loss (> 60 %) than did extracts from apical leaves of the susceptible variety.

2 - Effect of season

Extracts of apical leaves token during mid-july produced larger weight losses than extracts token during may, in both varieties

CONCLUSION

The phenolic extract from apical leaves of the resistant variety of peach is more harmful to *M. persicae* than extracts from the susceptible variety. This harmful effect increased from may to june in both varieties. The nature of the active substances and the toxic or repulsive character of their effects remains to be found.

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