a larger exchange interaction energy. This can be confirmed when a complete X-ray analysis of the crystal is undertaken. Further work on the line width variation with temperature on single crystals of these two compounds is in progress.

The authors wish to thank Prof. K. S. Iyengar for his help and encouragement. One of the authors (BAS) is grateful to C.S.I.R., for financial assistance.

1 Pepinsky, R., Vedam, K. and Okaya, Y., *Phys. Rev.*, 1958, **110**, 1309.
2 Anjaneya Sastry, B. and Sivarama Sastry, G., *Physica*, 1971, (under publication).
3. Anderson, P. W. and Weiss, P. R., *Rev. Mod. Phys.*, 1953, **25**, 269.
4. Locher, P. R. and Gorter, C. J., *Physica*, 1962, **28**, 797.
5. Kumugai, H., Ono, K. and Hayashi, I., *Phys. Rev.*, 1952, **85**, 925.

INDUCED APHID RESISTANCE IN *BRASSICA JUNCEA* COSS.

D. SRINIVASACHAR AND P. K. VERMA
Division of Genetics, Indian Agricultural Research Institute, New Delhi

ABSTRACT

In two commercial varieties of *Brassica juncea,* Laha 101 and R.L. 18, treated with different concentrations of the mutagens, ethylmethane sulphonate (EMS), maleic hydrazide (MH), ethylene imine (EI), diethyl sulphate (DES) and different dozes of gamma-rays, several plants highly resistant to the attacks of the aphids, *Lipaphis pseudobrassicae* (Davis), were isolated in the M_2 generation. The two varieties responded differently to the different mutagens, EMS and gamma-rays inducing more aphid resistant mutations in Laha 101 and HA and EI in R.L. 18. As aphid resistance may not be a case of simple inheritance effective control over the pest could be achieved by concentrating the resistant genes in a single strain.

INTRODUCTION

AN important part of any project of insect control is the search for the sources of resistance and utilize them in reducing the population of insects and the damage done by them. If the resistance genes are found in distantly related species and genera the problems of crossability, hybrid inviability and linkage of undesirable characters, usually accompanying distant hybridization, may render exploitation of such genes almost impossible. One is, therefore, faced with the problem of looking for resistance within the limits of the species. Where naturally occurring resistance genes are very few or not yet discovered within the parameters of a species, artificial induction of mutations for such characters assumes importance. However, at the present status of our knowledge the chances of getting such mutations cannot be predicted.

Of the three species of aphids, the cabbage aphid (*Brevicoryne brassicae* L.), the green peach aphid (*Myzus persicae* Sulz.) and the false cabbage aphid [*Lipaphis pseudobrassicae* (Davis)], known to attack the plants of the cabbage family, the last one is important in India as it is known to have completely wiped out the oleiferous *Brassica* crop in years of severe infestation. Besides directly devastating the plants the aphids also act as vectors to virus diseases.[4] In an aphis resistant rape (*B. napus* L.)[5] developed by crossing a swede hybrid (Calder × Superlative) with club root resistant rape the gene for resistance to cabbage aphid came from the Calder swede. There was a clear difference in the rates at which the aphids increased in the resistant and susceptible varieties[3] and in trials the resistant rape gave 50% more yield.[4] It was, however, not resistant to either the green peach aphid or to the false cabbage aphid. Under artificial conditions of infestation *B. napus* was found to be resistant and *B. Tournefortii* and *Eruca sativa* tolerant to the false cabbage aphid.[6] A glossy mutant of kale (*B. oleracca* var. *acephala*) was found to be resistant to cabbage aphid.[9] It is thus seen that there are very few aphid resistant genes in the genus *Brassica.*

EXPERIMENTAL RESULTS AND CONCLUSIONS

Seeds of two commercial varieties of *B. juncea*, Laha 101 and R.L. 18 were treated with three different concentrations of the mutagens, ethylmethane sulphonate (EMS), maleic hydrazide (MH), ethylene imine (EI), and diethyl sulphate (DES) and also irradiated

with three different dozes of gamma-rays. The M_2 families raised in a randomized replicated design were scored for aphid reaction under field conditions. Plants on which only a few aphids were found and which showed no apparent signs of aphid injury were rated as highly resistant, those that were inherently less damaged or less infested than the untreated controls under comparable environmental conditions as resistant and the rest as susceptible.

In the variety Laha 101 out of a total population of 2837 scored, 136 plants (4·79%) were highly resistant, 432 (15·22%) resistant and the rest susceptible to aphids. For the variety R.L. 18 in which 2,592 plants were scored the comparable figures for the highly resistant and resistant classes were 86 (3·31%) and 127 (4·89%) respectively. Thus the two varieties responded differently to the mutagenic agents. Gamma-rays and EMS were effective in inducing resistance mutations in Laha 101 whereas EI and HA were effective in R.L. 18 on which DES and gamma-rays, in the doses used, were less effective and EMS not effective at all (Table I).

TABLE I

Percentage of plants, highly resistant, resistant and susceptible to the aphid, Lipaphis pseudobrassicae *in the different mutagenic treatments in the* B. juncea *varieties, Laha 101 and R.L. 18*

Treatments	Laha 101			R.L. 18		
	Highly resistant	Resistant	Susceptible	Highly resistant	Resistant	Susceptible
EMS: 0·2%	10·9	25·9	63·2	0	3·9	96·1
" 0·4%	8·8	28·8	62·4	0	3·6	96·4
" 0·6%	4·6	15·5	79·9	0	3·4	96·6
Total ..	8·1	23·4	68·5	0	3·6	96·4
HA: 0·05%	6·3	11·4	82·3	3·1	2·6	94·3
" 0·10%	0	0	100·0	4·7	3·3	92·0
" 0·15%	0	0	100·0	5·9	1·5	92·6
Total ..	2·1	3·8	94·1	4·6	2·5	92·9
EI: 0·5%	4·7	20·5	74·8	0	5·9	94·1
" 0·10%	7·3	20·5	72·2	0	4·9	95·1
" 0·15%	0	0	100·0	17·2	8·0	74·8
Total ..	4·0	13·7	82·3	5·7	6·3	88·0
DES: 30 min.	3·1	20·4	76·5	0	8·5	91·5
" 60 "	0	0	100·0	2·8	3·9	93·3
" 90 "	0	0	100·0	0	7·0	93·0
Total ..	1·0	6·8	92·2	0·9	6·5	92·6
Gamma-rays: 80 kr.	2·9	20·9	76·2	0·5	4·0	95·5
" 100 "	15·0	24·4	60·6	0	5·7	94·3
" 120 "	8·7	29·5	61·7	4·4	13·0	82·6
Total ..	8·9	24·9	66·2	1·6	7·6	90·8

Segregation ratios for the different categories of aphid reaction indicate that aphid resistance may not be a simply inherited trait but may involve a few genes. By crossing the highly resistant plants *inter se* it is possible to concentrate the resistance genes in a single strain of *B. juncea* which although not immune to the attack of aphids will nevertheless hamper the pest in such a way that other controlling mechanisms, biological and chemical, become more effective.

Factors responsible for the relative resistance of plants to aphid attack are not very well understood. Differences in the waxiness of plants occur between species of *Brassica* and may be correlated with relative susceptibility to aphids.[8] Rape and kale (*B. oleracea* var. *acephala*) having blue-green leaves are susceptible to aphids whereas turhips (*B. rapa*) having bright green leaves are resistant. Non-waxy mutants arising from a waxy kale were not found to be infested by the cabbage aphids.[9] In glossy leaved brussels sprouts (*B. oleracea* var. *gemmifera*) resistance to cabbage aphid but increased susceptibility to green peach aphid was found.[10] Waxes and related substances are present as an integral part of the cell cytoplasm as well as forming cuticular wax in varieties of *B. oleracea*.[2] Qualitative as well as quantitative differences in the cytoplasmic wax contents may be of importance in connection with aphid resistance. Varieties of *B. oleracea* and *B. napus* contain either 15-nonacosanone ($C_{29}H_{58}O$) or 15-nonacosanol, the ketone and alcohol from *n*-nonacosan. While both are present in brussels sprouts neither were identified in white mustard (*B. alba*) which is known to be fairly resistant to cabbage aphids.

Other factors, besides waxiness, may be involved in aphid resistance. The mustard oil glucoside, sinigrin, has been found to be a specific stimulus for host selection by cabbage aphid.[10] Lines of kale with some resistance to aphids but not with waxless leaves can be bred. Perhaps they have a low sinigrin content. It would appear, therefore, that although sinigrin may be a specific stimulus for selection of the host by the cabbage aphid, reaction

to aphid is determined by the waxy and non-waxy nature of the Brassica plants. Resistance of rape to attacks by the cabbage aphid is said to have resulted from a combination of host non-preference and antibiosis.[3] Resistance to false cabbage aphid in tetraploid toria (*B. campestris* var. *toria*) is attributed to antibiosis.[7] Chromatographic analysis of several varieties of peas and the aphids infesting them showed that the varieties susceptible to pea aphid attacks contain a higher concentration of amino-acids than the resistant varieties with the exception of the amino-acid proline.[1]

We are grateful to Dr. M. S. Swaminathan, Director, I.A.R.I., for his encouragement.

1. Auclair, J. L. and Maltais, J. B., *Canad. Ent.*, 1950, **82**, 175.
2. Chibnall, A. C. and Piper, S. H., *Biochem. J.*, 1934, **28**, 2209.
3. Dunn, J. A. and Kempton, D. P. H., *Ann. Appl. Biol.*, 1969, **64**, 203.
4. Lamp, C. A., *Tasm. J. Agric.*, 1965, **36**, 21.
5. Palmer, T. P., *NZ. J. Agric.*, 1960, **101**, 375.
6. Shiv Raj, Singh, Narain, A., Srivastava, K. P. and Siddique, J. A., *Indian Oilseeds J.*, 1965, **9**, 215.
7. Rajan, S. S., *Ibid.*, 1961, **5**, 251.
8. Thompson, K. F., *Nature, Lond.*, 1963, **198**, 209.
9. Way, M. J. and Murdie, G., *Ann. Appl. Biol.*, 1965, **56**, 326.
10. Wensler, R. J. D., *Nature, Lond.*, 1962, **195**, 830.

ACTION OF ANTIBIOTICS AND AN IMIDAZOLE DERIVATIVE ON *DRECHSLERA PEDICELLATA*, A ROOT ROT FUNGUS

SHANKER BHAT SULLIA

Department of Botany, Bangalore University, Bangalore

ABSTRACT

The action of two antifungal antibiotics, hamycin and chainin and an imidazole derivative on *Drechslera pedicellata* (Henry) Subram. and Jain, a root rot pathogen of maize and several grasses, was studied *in vitro*. Hamycin and the imidazole derivative completely inhibited the growth of the fungus at 5·0 μg/ml concentration in potato-dextrose-agar medium. The minimum concentration of hamycin showing a growth-retarding effect was 0·01 μg/ml while that of the imidazole derivative was 0·5 μg/ml. Chainin inhibited fungal growth completely at 10 μg/ml. The minimum effective concentration was 1·0 μg/ml.

Hamycin induced remarkable morphological abnormalities in the mycelium while the other chemicals did not. Low concentrations of hamycin (0·01μg/ml) caused nodulation of the hyphae and at higher concentrations (0·05–0·1 μg/ml) vesiculation of the mycelium occurred. This led to pronounced cell membrane damage and the lysis of hyphae resulting in leakage of intracellular contents.

INTRODUCTION

CHEMICAL control of root disease fungi has become more feasible with the present knowledge that chemicals administered through foliar sprays are translocated to roots and change the pattern of root exudation.[1,6,11] Among the chemicals used as fungicides, antibiotics are gaining increasing popularity. Antifungal antibiotics are produced by several fungi, bacteria and actinomycetes[2] and these, in the natural soil environment, play an important role in modifying the soil microflora. However, the *in vitro* activity of several of these antibiotics may be quite different from their influences *in vivo*. In addition to antibiotics, the remarkable biological properties of several derivatives of imidazole have been recently demonstrated.[8]

A fungus recently isolated from rice field soils[7] evoked considerable interest. This fungus, *Drechslera pedicellata* (Henry) Subram. & Jain, is known to cause root rot diseases in maize and several grasses.[5] It was noted that the fungus showed a high degree of resistance to the organophosphorus fungicide "kitazin" sprayed on the field for experimental purpose. It was therefore thought worthwhile studying the effect of some antifungal substances on the growth of this fungus. Two of the fungicides used here are polyene antibiotics, hamycin and chainin and the third is an imidazole derivative (N, N-diethyl-*p*-imidazol-*1*-*yl*-phenyl phosphonothionic amide). The *in vitro* activity of these chemicals is described in this paper.

EXPERIMENTAL

All the growth experiments were conducted using potato-dextrose-agar medium. Different