ORGANISATION EUROPÉENNE ET MÉDITERRANÉENNE POUR LA PROTECTION DES PLANTES
EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION

78/7 - 3447/80

EPPO CONFERENCE ON BREAK-THROUGHS IN RESISTANCE BREEDING

Svalöv, 20-22 June, 1978

To : Participants

Dear Sirs,

A new version of the conclusions and recommendations from this Conference, revised in the light of the comments made during the closing session, is enclosed.

We should be grateful if you could check whether this constitutes an accurate account of what was finally agreed, and make any comments by the end of July. If no comments are received from you, we shall assume that the document is accepted and circulate it to the plant protection services of Member Countries.

Yours sincerely,

I.M Smith

Dr I.M. Smith
Deputy Director-General

Encl. : doc. 3448

Paris, 4th July, 1978

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EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION

78/9 - 3486

Report on the EPPO Conference on Breakthroughs in Resistance Breeding Svalöv, 20-22 June, 1978

The Conference, attended by 53 participants from 14 countries, studied recent advances in breeding for resistance to plant diseases and pests and modern strategies for the deployment of resistance.

The four principal papers were all devoted to questions of strategy. Prof. Hagberg (SE) reviewed past developments in breeding plants for resistance and emphasized the continuing need, and potential, for increasing resistance especially in cases where other control methods were not available. There had not generally been any great increase in the resources allocated to resistance breeding and much more could be done. There was now widespread movement away from the use of major genes (whose effectiveness was often only temporary) towards the use of varieties showing tolerance or various kinds of non-race-specific or "horizontal"resistance. Varieties with major-gene resistance could be used more effectively in mixtures or multilines, or else alternated in space or time. There were however numerous problems of organization, co-ordination, plant breeders' rights, etc., to be overcome before such deployment strategies could be realized. In addition, there were still problems in ensuring that breeding for resistance did not unacceptably decrease yield or quality, or conversely that breeding for quality did not create new disease problems. The example of Triticale was cited as a case for"genetic engineering" to combine the desirable qualities, resistance included,of wheat and rye.

Prof. Fischbeck (DE) developed further the theme of plant protection strategies. He emphasized the need to move from a major gene-dominated attitude to the view of resistance as a quantitative character, which could be differently expressed in different regions. Neither specific nor non-specific resistance need predominate. In plant protection strategies, resistance should and could be integrated with crop rotation and cultivation methods (especially in low-input systems and with pesticides. Less fungicide can be used on cultivars with moderate resistance, and the two complementary protection components stabilize the selection on fungi. Plant breeders now had a responsibility to establish priority rankings for diseases and pests of each crop in each area of its distribution and to establish sufficient genetic variability for resistance to provide a system of reasonable long-term stability.

Dr Barrett (GB) drew particular attention to the potential of variety mixtures for the control of cereal diseases. In the United Kingdom, extensive field trials had been carried out using mixtures of barley varieties each with a different major gene for resistance to powdery mildew. These mixtures could be expected to show the advantages of multi-lines, with the same condition that their success depends on stabilizing selection against mildew genotypes with excess virulence. Field observations had clearly shown reduction in

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powdery mildew and improvement in yield in the mixtures by comparison with the mean of the varieties grown singly. Genotypes with two or three virulence factors (i.e. excess virulence) were found to be present but not to show any tendency to increase in frequency. A mathematical model of pathogen evolution on variety mixtures had been developed and fitted well with the results of the monitoring program. It was emphasized that variety mixtures had a number of important advantages over multi-lines : they could be produced immediately and marketed without the problems of multi-lines; they were flexible, since numerous different combinations were possible and, indeed, preferable; mixtures could be devised with several diseases in mind, while multi-lines ran the risk of susceptibility to diseases other than their primary target; suitably used, they avoided the risk of a gradual adaptation of the genetic background of the complex pathogen race so that it is no longer selected against. Experience in United Kingdom showed that the mixtures could easily be chosen for homogeneity of quality and maturity. Farmers, plant breeders and industry were all showing rapidly increasing interest in these developments.

Dr Browning (USA) drew special attention to the need to study indigenous ecosystems in order to understand the relations between host and pathogen populations. Successful work in the USA on the use of oat multi-lines directed against Puccinia coronata was being compared with data from Israel on the same host/parasite combination in a natural ecosystem. P. coronata showed a very clear all-or-nothing distribution on individual oat plants in Israel, presumably corresponding to a population structure with multiple specific resistance and virulence genes. This was possibly connected with the presence of the alternate host Rhamnus palestina, on which gene recombination would readily occur. In contrast, P. graminis avenae was more homogeneously distributed and oat populations appeared to have levels of non-specific resistance to this pathogen rather than multiple specific resistances. The fact that the population structure of indigenous oats in Israel with respect to crown rust resistance appeared essentially to be of the multi-line type gives great confidence that the multi-line approach is biologically sound and more generally that workers on any crops can use diversity with confidence if disease is serious enough to justify developing an agronomically acceptable disease population and they have the resistance genes requisite for the job. There was a great need for further studies on population structure and diversity in natural disease systems, in order to test the many current theoretical views on the subject. However, it was then essential to ensure the preservation of these systems in their natural living state, and not "frozen" in gene-banks. This was an urgent problem in view of the pressures of agriculture on natural ecosystems. Israel had already taken positive steps in this direction.

A series of shorter papers dealt with various aspects of disease-resistance breeding in specific crops. Murty (India) reported on a very successful program for breeding for resistance to downy mildew in pearl millet. The high susceptibility of the male-sterile female parent used in producing hybrid millet had been corrected by gamma radiation-induced mutation. Resistance had also been diversified from various new West African and Indian donors and was also being selected for in the male parents. The resistance of the hybrid millet had remained stable and was combined with a wide range of desirable agronomical features.

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Dr Magnhild Umaerus (SE) discussed the problems of integrating resistance breeding with breeding for quality and yield in potato. The blight resistance program now centred on non-specific resistance. Breeding for resistance to storage rots was an important new aspect and work was continuing on the improvement of screening methods and on resistance mechanisms.

Julen (SE) reported on the successful use of intensive population selection within varieties to develop sub-populations of lucerne with high resistance to Verticillium albo-atrum. One such sub-population, with superior agronomic value, had been released under the name of "Sverre". The resistance was readily transferred by crossing. It has thus been possible to exploit a considerable "reserve" of resistance within existing varieties of lucerne.

Gondran (FR) discussed the principles on which the development of a resistance breeding program for forage crops shoudl be based. French breeding programs had successfully developed stable and effective non-specific resistance in forage crops, for example to Verticillium wilt in lucerne.

Schmidt (CH) reported on the fairly newly recognized bacterial disease of ryegrass caused by Xanthomonas graminis. Cultivars showing resistance in glasshouse tests with artificial inoculation also gave good scores in the field. They included some Swiss varieties which had been selected under high natural infection pressure at Zurich-Reckenholz. However, only slight increases in resistance were obtained by screening highly susceptible cultivars under glasshouse conditions.

Lundin (SE) gave the point of view of a scientist working in commercial cereal breeding. The wheat breeder has to balance the need for resistance against the possible demands of at least thirty other important and mostly polygenic characters. It is impossible in practice to combine all the desirable resistances into one high-quality variety and compromises are inevitable. Good durable major genes are still plentiful and other which fail in some localities may for various seasons be durable in other localities. The breeding of multi-lines was considered to be a slow operation and conservative with respect to other characters.

Developments in breeding for race non-specific resistance, usually polygenically controlled, were now of great interest and the combination of major and minor genes was an important target. The most suitable strategy had to be developed for each crop.

Fajemisin (Nigeria) reported on the successful use of mass selection for upgrading the level of resistance to several diseases simultaneously in a maize population with a wide genetic base. The value of this approach was emphasized for crop improvements in the tropics.

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Several papers were devoted to developments in breeding for resistance to animal pests.

Harris (USA) emphasized the fact that most sources of germplasm for resistance to arthropods are "allopatric", or in other words are composed of plants which have evolved their resistance in the absence of the arthropod in question. The possibility also exists of co-evolution of plant and arthropod to give a population with moderate resistance as a consequence of natural selection pressures. However, studies on the walnut caterpillar on wild pecan trees in Texas failed to show much variation in susceptibility between individual trees and various other examples also suggest that a plant population which has co-evolved with an arthropod is likely to be a poor source of germplasm for resistance breeding. It was noted that this contrasted with the situation for disease resistance.

Andersen (DK) reported on progress in developing resistance to Heterodera avenae in oats. Twelve high-yielding resistant varieties were now available to the farmer. Testing was simplified by the use of a marker gene closely linked to the gene for resistance. Bournoville (FR) reported that American lucerne varieties with resistance to alfalfa weevil and pear aphid were not necessarily so resistant when tested under French conditions. The appearance of biotypes of insects was generally considered less probable than that of new races of fungi, but the possibility was always there, especially for aphids.

The paper from Anglade (FR) stressed the value of international co-operation in breeding for resistance to Ostrinia nubilalis in maize. Breeding lines are tested in 13 European countries and the results brought together and analyzed centrally. Assessment methods can be standardized and components of resistance defined.

De Ponti (NL) discussed the value of incorporating resistant or partially resistant varieties into integrated control systems for glasshouse pests. Cucumber varieties with resistance to Tetranychus urticae could be used with fewer pesticide applications and with more reliable biological control by Phytoseiulus persimilis.

Cucumbers with resistance to Trialeurodes vaporiarorum were not found but hairless mutants were shown to allow much greater mobility of the parasitic wasp Encarsia formosa, to such an extent that this biological control agent could be used as well on cucumber as on tomato. The great value of resistance in integrated control was emphasized.

Two final papers related to the maintenance of genetic collections for research and breeding work. Eriksson (SE) described the nematode bank maintained at Uppsala on plant tissue cultures. The need for maintaining and publicizing collections of races of pests and pathogens was generally agreed. Kahre (SE) spoke on the value of gene banks of host germplams. He emphasized that, although conservation as such was of great importance, there was a vital need for evaluation of all new material, for international co-operation between specialist institutes, and for good and freely available documentation.

In general discussion, participants attached great importance to the enormous scope still existing for protecting crops by resistance breeding and to the need for developing strategies for the best use of existing resistance, both nationally and internationally. A set of conclusions and recommendations was drawn up (doc. 3488).

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The final day of the meeting was spent visiting the research laboratories and field trials of the Swedish Seed Testing Association at Svalöv, and also the Weibullsholm Plant Breeding Institute at Landkrona. Participants were able to see a number of the most successful varieties of cereals and other crops bred at these Institutes, to hear about their complex ongoing plant breeding programs and to appreciate in practice the application of many of the principles which had been developed by speakers at the Conference.

Paris, September 1978

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78/9 - 3488

EPPO CONFERENCE ON BREAK-THROUGHS IN RESISTANCE BREEDING

Svalöv, 20-22 June, 1978

CONCLUSIONS AND RECOMMENDATIONS

Step 1

The Conference, attended by 53 participants from 14 countries, studied recent advances in breeding for resistance to plant diseases and pests and modern strategies for the deployment of resistance.

The following conclusions were drawn :

Conclusions

1. Breeding for genetic resistance is the most fundamental and desirable method of plant protection. The use of resistant plants can in many cases lead to avoidance of pesticide use and entails no comparable toxicity or ecological hazards.

2. Programs of resistance breeding continue to exploit reserves of resistant germ-plasm. Resistance is still readily found, by an ever widening range of breeding and testing methods, from population improvement to mutation breeding.

3. The successful use of resistance depends in most cases on the maintenance of genetic diversity. The use of multilines and variety mixtures in inbred crops, and of multiple crosses and improved populations in outbreeders, offer important ways of establishing this diversity.

4. Gene deployment offers a method of maximizing the effectiveness of existing genetic resources, for example by using different genes for powdery mildew resistance in spring and winter cereals, or in different areas of cereal cultivation. Strategies for gene deployment will depend on basic research on the prevailing sources and dispersal of pathogen and pest races.

5. Genetic resistance is a most important and basic component in the development of integrated control of diseases and pests. This can involve the integrated deployment of resistance genes, biological control agents and pesticides.

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These conclusions led to the following recommendations :

Recommendations :

1. That priority should be given to resistance breeding as a biological plant protection method, that resistance to animal pests should be specially considered, and that an interdisciplinary approach should be encouraged in this respect between pest and disease experts and plant breeders.

2. That advances are required in the methodology of selection and especially of the assessment of minor differences in resistance.

3. That the collection and preservation of gene-bank material should continue and in particular that this material should be fully evaluated by collaboration between leading institutes. In appropriate cases, collections of pest and pathogen races should be maintained for breeding work.

4. That there should be a free exchange of information on the sources of resistance used in newly released varieties.

5. That germ-plasm preserves should be established in natural ecosystems and that research should be undertaken in these preserves on the interactions of hosts, pests, pathogens and their natural enemies in natural indigenous populations. This research could lead to new understanding of possible biocontrol agents and tactics.

6. That encouragement should be given to the evaluation and utilization of multilines, variety mixtures and other methods for achieving the level of genetic diversity needed. The possibility should be considered of establishing an international working group to recommend gene deployment policies on a European scale.

7. That, in certain cases, excessive use of resistant cultivars should be limited when the risk of disease or infestation can be assessed to be low.

8. That breeding procedures using specific resistance should be reinforced by a background of non-specific resistance.

9. That strategies should be developed for the integrated deployment of resistance genes, or of combinations of resistant varieties, pesticides and cultural practices that maximize natural control processes.

Paris, 5 September, 1978