

Cornell University Lands Grant for Pepper Work

During the first year, the Commission funded a single project. The second year, Dr. Bosland's project was added. In this, the third year of the research program, another project has been added. The project is directed by Dr. Molly Kyle of Cornell University in New York and is



The Kyle Pepper Group. (l. to r.) Dr. Molly Kyle, Julie Ho, Sue Fenton, George Moriarty, Dr. Jim Prince and Jim Blauth, PhD.

aimed at finding the genes that control virus resistance in peppers. An exciting development occurred recently when Dr. Kyle found out that the project has received a substantial grant from the U.S.D.A. to augment the Commission funds. This will allow the work to proceed with more help and equipment than previously thought. Even though the project has only recently started, Dr. Kyle has submitted the following progress report:

Viral diseases continually threaten both the yield and quality of California's pepper crops. Because there are no chemical or other controls for viral disease, plant resistance using either naturally occurring plant genes or other genes engineered for resistance, remains the best way to control losses from these diseases. However, it has not yet been possible to develop breeding lines with resistance to the major viruses that appear regularly in the state. This is due to difficulty in identifying good sources of resistance to the viruses, and difficulty in maintaining high levels of resistance during the transfer from resistant sources to horticulturally outstanding advanced breeding lines for the diverse types of pepper.

At Cornell University in Ithaca, NY, Drs. Molly Kyle and Rosario Provvidenti have an ongoing collaboration to locate sources of resistance to viral diseases of vegetables and characterize the genetics of the responses. Dr. Kyle, Assistant Professor in the Department of Plant Breeding, is a vegetable breeder with research interests in the genetics of virus resistance in plants, and Dr. Provvidenti, Professor of Plant Pathology at the experiment station in Geneva, NY, is an internationally recognized authority on viruses of vegetables. In pepper, their overall objective is to facilitate efficient transfer of multiple virus resistance to commercial types using conventional and other methods of selection. They and

Fernando Loaiza-Figueiroa, now with Asgrow Seed Co., have located novel sources of resistance to a number of viral diseases of pepper including CMV, TSWV, TMV, alfalfa mosaic virus and broad bean mosaic virus.

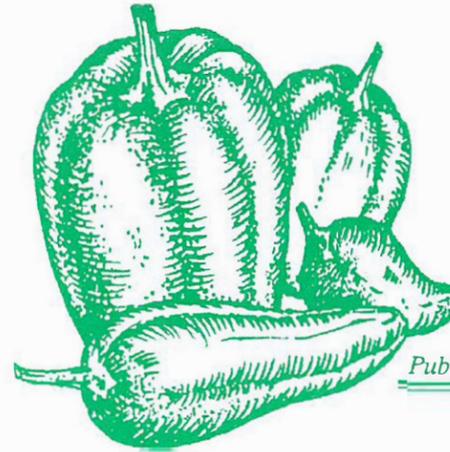
With support received from the CPIF and the CPC, Dr. Kyle initiated a program that aims to identify markers (similar to a distinct label) linked to genes for resistance to cucumber mosaic virus, the related viruses, pepper mottle, tobacco etch and potato virus Y, and tomato spotted wilt virus. These markers are distinctive points on the chromosomes very near to the desired resistance genes that can be identified in the laboratory using the techniques of molecular biology. Using markers that are linked to resistance genes, they can screen an individual plant for resistance to several diseases without the usual problems of viral variability or symptom expression. These markers can also identify desirable genes when they are present but masked by other genes and therefore remain hidden in the whole plant. Dr. Kyle has just been awarded a competitive grant from the U.S.D.A. for \$260,000 to continue this work for the next three years. She plans to work closely with the UC Davis group and researchers at several seed companies to develop selection strategies that meet the needs of commercial plant breeders so they can better respond to requirements of the industry.



California Pepper Commission Financial Report

Fiscal Year: May 1, 1990 through April 30, 1991

Account Name	
INCOME:	
Carry-over	\$ 46,051
Assessment Income, 1990-91 (Based on combined rate of \$.50/ton)	140,080
Interest	<u>6,045</u>
Total Income	\$ 192,176
EXPENDITURES:	
Attorney's Fees	2,547
Management Services	24,000
Audits	1,900
Office Supplies	641
Telephone	482
Postage	775
Travel & Mileage	826
Meetings	1,052
Insurance, Taxes & Bonds	410
Marketing Branch	13,700
Production Research	<u>85,564</u>
Total Expenses	\$ 131,897
Carry-over Reserve to 1991-92	<u>60,279</u>
Total Expenses & Reserve	\$ 192,176



Pepper News

Published by the California Pepper Commission, 531-D North Alta Ave., Dinuba CA 93618

July 1991

— ANNUAL REPORT ISSUE —

Progress, 1990-91

Understandably, the work of solving problems with virus is somewhat "invisible". Some of you may be wondering what the Pepper Commission is doing with the assessments that are collected. The Commissioners and their staff hope that this newsletter will inform you of the research progress made this year. Summaries of the reports are given by the researchers so that you will be able to get the main thrust of their projects. For some of you this may not be enough — you would like to see the tables of information which detail the specific results. The Commission staff would be more than happy to send you complete copies of the research reports at your request. Simply call (209-591-3925) or write for the complete technical reports.

The question of the hour seems to be, is there a solution yet? The answer, no. Breeding work is usually a long term process taking many generations of the plant in order to obtain the desired results. The researchers are making and tracking a great number of crosses (550 in the case of the Davis project) in order to find the best resistance quickly. Still, the process is not a quick one. Please read "A Breeding Primer" later in this newsletter to get a better feel for the process involved in a breeding program.

The Commission is fulfilling its mission to bring industry resources to bear on industry problems. The research budget is 161% greater than the 89-90 amount and now constitutes 58% of the overall budgeted expenditures. The 91-92 year increases research by another \$21,900 which now means that 64% of the budget goes to research. Please enjoy reading about the fruits of your financial efforts.



Pepper Virus Work at Davis Progresses

The Pepper Commission is sponsoring work at Davis to identify sources of virus and find resistant sources. This

work is being conducted by Robert Webster, Albert Paulus, Gura Gurasinghe and headed by Dr. Bryce Falk. The results of their work in 1990-91 have been summarized in the next few paragraphs.

This past year, pepper virus incidence was monitored throughout California. With the cooperation of the county farm advisors, 172 virus-infected samples were collected and analyzed using the most modern techniques. Many of the samples were infected with two or three viruses. Potyviruses were by far the most common virus found in all regions of the state. About 12% of the samples tested positive for CMV. Based on the results of these tests and those of previous years, potyviruses are likely the most widespread and consistent virus problem to affect California peppers. CMV appears to be a more sporadic, but occasionally very severe threat.

Secondly, the Davis team sought to compare potyvirus and CMV isolates from various locations on a range of standard indicator plants. A variety of reactions was observed, especially for the potyvirus isolates. The antisera for each potyvirus (TEV, PVY, PeMV) allowed for easy distinction between one another; however, they would not allow differentiation between strains of the same virus. In an attempt to resolve this problem, industry representatives were consulted and a group of pepper types were chosen which have increasing levels of resistance to potyviruses. The group selected, in order of their resistance, was: Early Cal Wonder, Yolo Y, VR2, Agronomico 10, VR4, Delray Bell, PI 159225, PI 159236, Green Leaf Tobasco. The results indicate that there is pathogenic variability in the naturally occurring potyvirus isolates. Some of them are able to infect plants which are normally considered resistant. As of yet, there is no means of efficiently identifying the isolates.

The initial work on CMV was to determine the best conditions for getting this virus into the test plants. CMV is a finicky virus which is unstable and has a very short time span for transference to the plant. A method for inoculation has been developed that is reliable; however, the group has not yet found a good way of screening and

evaluating for CMV. These studies will be done more intensely this coming year.

The final objective for the Davis group was to develop pepper types that are resistant to CMV, PVY, TEV, PeMV and possibly TSWV and to incorporate resistance to Phytophthora and Verticillium. To accomplish this the group began crossing as many of the resistant lines as they could during the flowering time. This resulted in over 550 crosses which are being tested for resistance

A Primer on Plant Breeding

Since the primary emphasis of the Pepper Commission is research and a significant portion of that research deals with breeding, we would like to offer a short course on understanding the terms used by breeders.

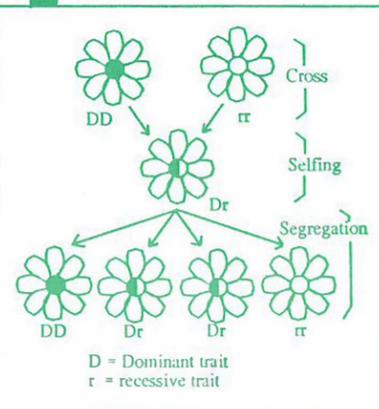
Crossing: A process where two plants or parent lines with different characteristics are pollinated to obtain seed. This usually requires that the female parent have the pollen removed from its flowers (emasculation) so that self-pollination does not occur. Pollen is then transferred from the other parent (male) and placed on the female portion of the first plant which results in "crossing" or "cross pollination". This process is used to combine genes from the different parents into a single plant.

Selfing: or Self-pollination occurs where the pollen (male gametes) and ovules (female gametes) from a single plant unite to form seed. This is done to observe and select among the next generation of plants (progeny) to find the desirable plants. Segregation is the dividing up of these progeny by the characteristic the breeder is striving for so that only plants with desirable characteristics are selected. The more you self a line, the more uniform (homozygous) it will become.

Segregation: The traits carried in the plant's genes come in pairs and for a particular trait are: both dominant, both recessive or one dominant and one recessive (which shows only the dominant trait externally). If we cross a TEV resistant plant with a TEV susceptible plant, the resulting seed (F₁) will produce all TEV susceptible plants (as the gene for TEV resistance is recessive, i.e. hidden behind the dominant trait of susceptibility). By selfing the seed from these plants, the next generation (F₂) will produce plants in the ratio of three susceptible plants to one resistant plant. This is because approximately one in four of the seeds will have gene pairs which are both recessive. Selecting only those plants with the desired characteristic constitutes segregation.

Backcross: Once you have crossed two plants, backcrossing refers to repeatedly crossing the offspring back to a very good parent (recurrent parent) in an attempt to have the end product look like the good recurrent parent, except for a few characteristics. An example would be to cross Jupiter to Delray Bell (which has TEV, PeMV and PVY resistance). The resulting plants would be selfed and their offspring selected for virus resistance and crossed again to Jupiter for perhaps up to 15 times to end up with a pepper line that looks like Jupiter, but also has TEV, PeMV and PVY resistance.

Why it takes so long: The breeding process depends on several factors: (1) the number of genes for virus resistance you are selecting for, (2) the horticultural differences between the resistant parents and the susceptible parents, (3) genetic difficulties, especially when resistance genes you want are linked together with genes you don't want (like small fruit size), (4) the variability of the viruses and their ability to overcome resistance from different sources, (5) the efficiency and accuracy of the screening techniques to select for virus resistance. For example, if you have bell pepper plants which are horticulturally great and have a single resistance to either TMV, PeMV, PVY, TEV or CMV, the resulting cross and segregation cycle would result in only 3 of 164 possible gene combinations being resistant to all five viruses. If you have to use a pepper that looks like a seranno to get one of the resistances you need into your bell pepper, the resulting F₂ generation will segregate into an enormous number of possibilities because there are now thousands of genes involved. The chances of coming out with something that looks like a nice bell pepper are very small. Therefore, you must begin a process of backcrossing with the most promising material. If you throw in further complicating factors like desirable genes linked with undesirable genes and being unable to screen for more than 2 or 3 viruses at a time, the time and expense becomes very great.



with only the most promising results being retained.

At the same time, supposed sources of resistance were selfed and tested to prove their resistance. These lines were tested against the newly acquired strains of CMV. The tests show that CMV resistance is variable and not always carried forward from the parents. The tests also show that resistance to CMV is strain dependent. Therefore, we are not only faced with incorporating resistance for a number of viruses into a single line, but also with finding resistance genes to different strains of CMV.

At the request of the Commission, efforts are being concentrated on different pepper types (Bells, chillies, etc.) to provide resistance in each type. The second generation of backcrossing will be done to concentrate resistant genes into plants that are closer to the desired

commercial types. They have crossed the best potential CMV resistant lines with commercial Bell types, Jupiter and Verdel; and soon the chili type Capistrano will also be included.

Finally, to insure that the peppers are truly able to sustain resistance to actual viral pressure, plantings of the crosses and parental lines are being grown in several areas. These plantings in Gilroy, Merced and Davis will allow detection of viral strain differences at varying loca-

tions. Additional plantings at Irvine, Santa Maria and Greenfield are also planned.



Dr. Paul Bosland Reports on First Year Breeding Work

Dr. Paul Bosland has been working for the Pepper Commission for a year now on a project called "Developing Enhanced Pepper Germplasm Resistant to Verticillium Wilt". Research on verticillium has been conducted by Dr. Bosland since 1987 with support from the Commission beginning in 1990. A summary of his progress report follows:

Pepper cultivars resistant to Verticillium wilt are urgently needed in many pepper growing areas of California because no satisfactory cultural or chemical control exists. The first sources of genetic resistance to Verticillium wilt were found at New Mexico State University during 1987-89. A resistant population is being developed from one of these sources. The second selfed generation (S₂) of the original source of resistance is a donor parent in a backcross breeding program. This source is not 100% resistant to Verticillium wilt. The level of resistance was 68% for the first selfing (S₁). A second generation (S₂) was grown and screened to increase resistance. It is this population that is the resistant donor parent. The seeds of the most resistant plants from the S₂ population were saved and will be selfed to produce an S₃ population.

During 1990, individual plants of an S₂ resistant population were crossed to the following three pepper types: "NuMex Joe E. Parker", a New Mexican type; "Early Jalapeno", a jalapeno type; and "Keystone Resistant Giant #3", a bell type. The F₁ seed was harvested in the Fall of 1990 and the recurrent parents screened for Verticillium wilt resistance.

The plants were screened under strict environmental control in soil temperature tanks. The soil was kept at a constant temperature and inoculated with a precise amount of Verticillium. The seedlings were challenged for 60 days and the plants scored by their visible characteristics. The results show that all backcrossed populations, the recurrent parent and the donor parent have susceptible individuals. Each line varies in its susceptibility with the resistant parent having the lowest disease levels. After three selfing cycles, the resistant parental line still segregates for resistance.

Our results indicate that Verticillium wilt resistance is a many-faceted trait. To genetically inherit resistance, many genes in the correct combination must be transferred. A knowledge of the dominance and additive effects of the trait will help plant breeders select the most appropriate breeding method for Verticillium wilt resistance.



California Pepper Commission

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Frank Luenser Arroyo Grande 805/489-2508	District 2	Vard Ikeda Arroyo Grande 805/489-2526
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