

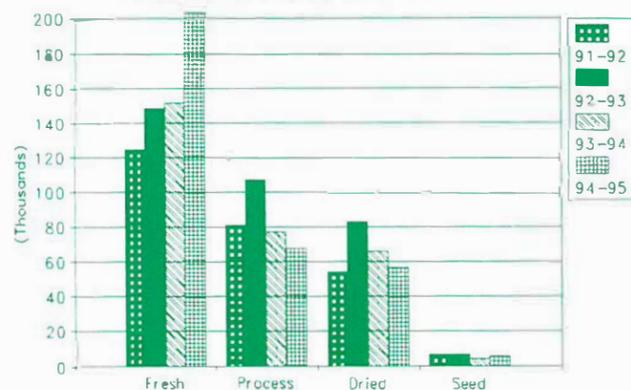
Commission Report

Continued from page 1

Here is a quick summary of the research highlighted in this issue. One of the key research projects financed by the Commission is that done by Molly Kyle. She is working with the three categories of peppers; bell, anaheim and jalapeno, to integrate CMV resistance. Other seed companies have successfully developed resistance for the other viruses, but CMV has proven very difficult. Our Farm Advisors who work with peppers have been laboring on aphid control (Valencia) using Admire and some numbered compounds as well as powdery mildew control (Smith). These have provided some interesting, though sometimes inconclusive, results. Gilbertson has successfully created a method to detect Curly Top Virus (CTV) in peppers in a shorter time. He has also found variations in the type of CTV found on peppers compared to that found on some other plants. Some of his work may help in developing CTV resistant peppers in the future. Finally, Dr. Bosland's work is beginning to bear fruit with the shipment of seed to California for testing in fields that are infected with Verticillium wilt. He believes that the level of resistance will allow for survival of enough plants to result in full production.

Pepper Assessments

Production in tons as if for fresh mkt.



1994-95 Crop

If you look at the "Pepper Assessment" graph above, a four year comparison is given showing the number of tons of peppers produced for the four destinations tracked by the Commission. Overall the crop is 111% of last year's, but is just a bit smaller than the 92-93 season. Different areas grow and shrink for various reasons which are not always apparent. This year seems to confirm that the fresh market is growing while the processed and dried areas are taking a smaller share.

Budget

Looking at the financial report, the expenditures were on budget with research expenditures running about 15% greater than the year before. This amount, \$118,285, went to finance the projects reported in this newsletter. The remaining 35% financed everything else — meetings, management, newsletters, marketing branch, office supplies, insurance, postage, Section 18 work, etc. The Pepper Commission has a small

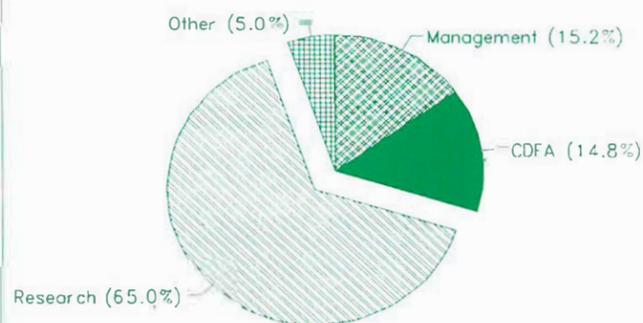
California Pepper Commission Financial Report

Fiscal Year: May 1, 1994 through April 30, 1995

Account Name	Amount
INCOME:	
Carry-over from 1993-94	\$89,283
Assessment Income, 1994-95 (Based on combined rate of \$.50/ton)	165,271
Prior Year Assessments	5,187
Interest	5,035
Total Income	\$ 264,776
EXPENDITURES:	
Management Services	27,600
Audits	1,600
Office Supplies	1,335
Telephone	477
Postage	600
Travel & Mileage	496
Meetings	382
Insurance, Taxes & Bonds	404
Marketing Branch	26,998
Production Research	118,285
Research Consulting	3,750
Total Expenses	\$ 181,927
Carry-over Reserve to 1994-95	82,849
Total Expenses & Reserve	\$ 264,776

budget and the Commissioners work hard to stretch your research dollars.

Pepper Commission Expenditures 1994-95



The Pepper Commission welcomes your comments and suggestions. Please feel free to contact one of the Commissioners listed or the Commission office at 209-591-3925.



Pepper News

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June 1995

— ANNUAL REPORT ISSUE —

Commission Report

Welcome to another edition of the annual report of the Pepper Commission. Work for the pepper industry is continuing on a broader range of fronts than in the past. In fact the number of projects supported doubled from three to six during the 1994-95 year. This broadening of the research efforts has not been at the expense of the primary goal of breeding resistance to the destructive viruses; rather, it has been in response to various short-term industry problems that need attention. For the upcoming year there will be on-going research by Kyle, Bosland, Gilbertson and Smith with the projects enumerated here. In addition, there will be new projects on Induced Virus Resistance and Pepper Stip to look forward to in 1996.

Research Work

The mainstay of the Pepper Commission is research work. The assessments that California pepper growers and handlers pay into the Commission go primarily for funding research work on the major viruses. The Commission funded six projects in the 94-95 year: two at UC Davis, one each at New Mexico State University and Cornell University and two Farm Advisor projects. A summary report from each of these projects is contained in this newsletter. This is an appropriate time to mention that the full text and charts for these reports can be obtained by writing the Commission office at the address on the masthead. There is no charge for the full technical publication.

Another question which often arises relates to the promotional activities of the Commission. The answer is simple — there are none. The Commission cannot engage in any promotion or legislative activities and will not be able to unless the industry changes the law with an industry vote. The focus of the Pepper Commission from its inception has been on research and will remain so until the industry desires otherwise.

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Development of Improved Sources of Resistance and Selection Strategies for Resistance to Pepper Viral Diseases

Molly Kyle, Cornell Univ, Ithaca, NY
607-255-8147

Our project for 1994 was intended to begin a comprehensive backcrossing program using the two leading sources of CMV resistance (CMR), *C. annuum* French Perennial, a Perennial line obtained from INRA, France that compared favorably with other versions of Perennial for stability and uniformity of CMR and *C. frutescens* BG2814-6. We made crosses directly with each of the recurrent parents representing the three major market classes in California, and also used CMR F₄ plants from a *C. annuum* RNaky x *C. frutescens* cross. In the bell type, we had been using Jupiter and have switched to Verdel, and in the Anaheim type, we had been using RNaky and have switched to a well adapted, obsolete, CalCompack variety, CalCompack 648 kindly provided by Paul Narewski. In the jalapeno type, Ken Owens of Petoseed Co., sent us a potyvirus-resistant jalapeno. We completed two generations during the work period, and successful spring and fall/winter disease screens. We were very glad to host Dr. Bob Heisey, Asgrow Seed Co., who visited and reviewed our program in December, 1994 and Drs. Alain Palloix and Veronique Lefebvre from INRA, France in January, 1995.

In July, 1994, we received a 3 year renewal of our *Capsicum* genome mapping project from USDA although at substantially reduced funding level from 1991-94, and we are continuing with the work which should complement the breeding supported by the CPC since one of our objectives is to identify linked molecular markers for CMR from *C. frutescens*. We had several changes in personnel, but we expect to continue a vigorous research program in pepper breeding, genetics and

molecular biology thanks in large part to support in 1994-95 from the CPC/CPIF.

Progress in Breeding for CMR

Bell: We are currently harvesting seed for the BC₂F₁ seed using Verdel for the last backcross and straight 14-6 and French Perennial as the sources of resistance with Jupiter used twice before Verdel as the recurrent parent, i.e. Verdel x (Jupiter x (Jupiter x 14-6 or Perennial)). We plan to screen a large number of BC₂F₂ individuals from progenies produced this summer in California when we receive the seed back in late summer, early fall, 1995 to see if we can recover resistant individuals to make the third backcross with Verdel in the fall. We do not know at this point whether we will be able to recover high levels of resistance in these progenies, since the second backcross was made with unselected BC₁F₁ parents.

We also produced BC₁F₂ seed from the Jupiter BC₁F₁ plants used above which we will screen, select and make the second backcross to Verdel. This represents the alternative strategy to that described above where we will select between the first and second backcross. We have also produced the F₂ and the BC₁F₁ generation from Verdel crossed and backcrossed to resistant F₄ selection with relatively large fruit from RNaky x 14-6.

For our genome mapping work, we generated two large Jupiter x 14-6 and Jupiter x French Perennial F₂ populations and screened them during the winter, 1994-95 for resistance to CMV V27. Resistant F₂ individuals with the most appropriate types from these populations were also backcrossed to Verdel. We also compared the CMV II44 isolate with CMV V27 and continue to use the V27 in our screens since the severity appears comparable, but V27 symptoms develop somewhat sooner under our conditions.

We are also using these large F₂ populations to analyze gene action and identify the map positions of the quantitative trait loci that confer material from the *C. frutescens* 14-6 and Perennial. It may be that while material from the Perennial crosses initially looks more like cultivated pepper, it is more difficult to discriminate the individuals with the highest levels of resistance in these crosses. In contrast, there are fewer highly resistant individuals in the F₂ populations with 14-6, but they have remained free of symptoms through fruit set and maturity, and we know there is more molecular polymorphism in this cross.

Anaheim: After discussions with the CPIF and concerned Commission members, we selected CalCompack 648 provided by Paul Narewski as the recurrent parent for the program because of its acceptable type and wide adaptability for both the coast and valleys. We have BC₁ and F₂ seed from 648 x the F₁ from 648 crossed with the (RNaky x 14-6) F₄ plants selected for CMV resistance and fruit size. We plan to screen the F₂ this spring, make selections and then make the first backcross using selected resistant F₂'s, and we will self the BC₁F₁ and backcross to get the second backcross and the BC₁F₂ to screen in the fall. We also have F₁ seed from Anaheim x French Perennial which we will self and use to make the first

backcross. Again, we expect we should be able to go at least two generations and will screen all F₂'s we generate during the year and use selected individuals as parents.

Jalapeno: In consultation with the CPIF, Ken Owens provided us with a jalapeno carrying resistance to tobacco etch virus, pepper mottle virus and potato virus Y from Del Ray Bell. We made the cross between this parent and the selected F₄'s and have BC₁F₁ and F₂ seed available now. We will send these lots to Ken for selection for type, CMV screening if possible and selfing, and then receive seed in the fall for additional crossing and screening. While we also have jalapeno crossed with French Perennial, we will emphasize the *frutescens* source since we are more confident about level of resistance and recovery of type in jalapeno from this source.

Resistance to Other Viruses

We are finishing our work on dominant pepper mottle virus resistance and will be screening a testcross population this summer to determine whether dominant resistance from Criollos do Morelos source and from *C. chinense* contain the same or different genes. Thus far, we have seen incomplete dominance in the gene from Criollos do Morelos moved into an RNaky background, while the gene from *C. chinense* showed complete dominance in Jupiter so we are determining whether this is a background effect or due to two distinct genes.

The French group has published a map position for the L locus and we are confirming this position in our materials. We do not yet have a map position for the recessive *C. chinense* potyvirus resistance gene despite a map with about 150 markers in place, but we will be adding several dozen markers to this map in the next few weeks representing several chromosomes in tomato which we have not had well covered to date, so we are hopeful we will have a position for this locus soon. We are continuing to work with *C. chinense* as a source of TSWV resistance to map that locus, and are working in collaboration with Dr. S.D. Tanksley to examine whether there are relationships between resistance genes from tomato and pepper.

Short Term Control Strategies of Aphid Control and Aphid-Induced Viruses

Jesus Valencia, Farm Advisor
209-525-6654

Three insecticide trials were conducted in Stanislaus County to assess the feasibility of Admire to control aphids and aphid-borne viruses on bell peppers. Admire was applied with the seed at Orestimba Farms, with transplant water at Miller Ranch and at side dressing at Del Mar Farms. Pan traps were installed on all fields to collect winged aphids as they were coming into

Develop a rapid approach for screening peppers for CTV resistance. We are now proceeding to obtain full-length infectious clones of CTV-pepper. DNA extracts were made from infected pepper tissue and curly top DNA was detected in these samples using the general CTV DNA probe. We have identified what we believe are unique restriction enzyme sites in the CTV-pepper DNA, (*Bgl* II and *Bam* HI). We have begun to attempt to clone the full-length curly top DNA by digesting the total DNA from infected plants. *Result: Effort is ongoing to obtain a full-length infectious CTV-pepper clone.*



Developing Enhanced Pepper Germplasm Resistant to Verticillium Wilt

Paul Bosland, New Mexico State Univ.
505-646-5171

In 1992 a source of resistance to Verticillium wilt was developed from the accession PI 215699. This population has attained a 75% level of resistance which has been determined to be the threshold level. Using this germplasm the New Mexico State University Chili Pepper Breeding Program was able to introgress resistance into three commercial pod-types: bell, jalapeno, and New Mexican. These three populations have been screened and the resistant plants selected for several generations. Currently, the bell and jalapeno type populations are in the F₄BC₁ generation and will be backcrossed this spring to produce the F₄BC₂.

Another source of resistance to Verticillium wilt has been identified from the accession PI 555614. After four cycles of screening and selection a resistance level of 56% has been achieved. Selection will continue until a threshold is reached. If a level of resistance greater than 75% can be reached, this population could then be used as a source population for the introgression of resistance to the commercial types. The ability to reach a level of resistance greater than 75% would indicate that a stronger genetic system for resistance is present.

Individual plants selected for "field-resistance" were screened and highly resistant individuals saved from four cycles of selection. Under present screening procedures, selecting "field-resistant" plants is not a feasible approach for selecting Verticillium wilt resistant peppers.

Because new sources of stronger resistance are continually being sought, evaluation of germplasm for resistance to Verticillium wilt has continued. Recently, germplasm from the International Hot Pepper Trial Network (INTHOPE) was acquired (via AVRDC) and 48 accessions were screened for resistance to Verticillium wilt. Of these accessions, ten lines were found to contain some level of resistance. These lines will

be rescreened to confirm resistance, and resistant plants will be saved to evaluate the level of attainable resistance.

To test a wider genetic base of germplasm, a total of 15 accessions of *C. frutescens*, 9 accessions of *C. chacoense*, 1 accession of *C. anomalum*, and 1 unknown species accessions were screened. In addition, a *Solanum* species and a *Physalis* species were included to test for a non-host resistance reaction. From the *C. frutescens*, five lines exhibited a statistically significant level of resistance higher than the susceptible control. One *C. chacoense*, the *Physalis* species, and the *Solanum* species had a statistically significant higher level of resistance. Even though *Physalis* and *Solanum* cannot be intercrossed with *Capsicum*, biotechnology may present an avenue for this process in the future. Resistant individuals were saved from the above populations. The increased seed will again be rescreened and selected.

The techniques used to screen for Verticillium wilt resistance have been reliable, but are time consuming and unique to our program. Investigations with a new "in-row" technique were completed. If successful, this method could save both time and labor while producing efficient screenings. The current procedure for soil infestation requires the use of a cement mixer in which the soil and inoculum are mixed together for one hour to evenly distribute the inoculum within the soil. With the new "in-row" technique, a quantified amount of inoculum is poured into the row where the seeds will be planted. The seeds are then in direct contact with the inoculum. Experiments using this method have been performed twice. The results show that the new technique does not produce a disease severity as high as the original method. One explanation for this is that the microsclerotia of *Verticillium dahliae* tend to infect the secondary roots (the root hairs) more than the main or primary roots. The root hairs develop away from the row in which they have been planted, thus avoiding the microsclerotia. In future experiments, the inoculum will be placed to the side of the planting row.

The New Mexico State University Chili Pepper Breeding Program is sending two lines of peppers to the California Pepper Commission for field evaluation of Verticillium wilt resistance. These lines have significantly higher resistance levels than the susceptible control. One line is jalapeno type that had "Early Jalapeno" as the recurrent parent. This population has shown a resistance level of 65%. The second line used the bell type cultivar, "Keystone", as the recurrent parent. This population is 53% resistant. Seed of PI 215699, the initial resistant source, will be sent along with these two lines for use as a resistant control in the field trials.



the fields. Aphids were counted on a weekly schedule on plants and traps. Plant samples from all fields were taken and analyzed for proper identification of virus types present in all three locations.

We also experimented with a Ciba # compound, Diazinon, and Dibrom for aphid control. These materials were sprayed on a weekly schedule after plants were established. For the Dibrom experiment, aphids were counted three and seven days after application to evaluate knockdown of aphids. After analysis was done we concluded that Admire and Ciba + Kinetic tended to reduce visual symptoms of virus on plants. Unfortunately, results were not statistically significantly different at the 5% level of confidence. Small plots did not allow us to fully evaluate dynamics and within-field spread of the disease from migrating and colonizing aphids. We feel there is a need for larger plots (1/4 acre in size or larger) in order to assess the impact of Admire on virus suppression.



Strategies to Control Powdery Mildew on Peppers

Richard Smith, Farm Advisor, San Benito
408-637-5346

The infection of powdery mildew in the Central Coast region was light to moderate during the 1994 season. We saw the first infection in a field in Gilroy on August 4th. By comparison, the first infections in 1992 occurred in early July and in 1993, which was a light infection year, by August 20. The date of first infection can give some indication of the severity of the season; however, late fields can still be devastated by late infections if they are unprotected, while early fields may escape problems.

At all of our trial sites the infections by powdery mildew were light and yield evaluations were not possible to obtain due to the lateness of the infections. The purpose of this year's evaluations was to test if early and frequent applications of protectant fungicide materials could help suppress infections of powdery mildew. The Gilroy site had the most severe infection of the three trial sites and as expected, the Bayleton and Rally applications at either 10 or 20 day schedules gave total control of the disease. Of interest, however, was that sulfur and 2236-15B gave good suppression of the disease. Stylet Oil gave statistically better control than the control, but it was clear at the later evaluation that the protection was breaking down. At the King City and Ausaymas sites sulfur showed complete suppression of powdery mildew. Pressure by powdery mildew at these sites however, was very light.

The results of these trials are further substantiated by the results from the sulfur strip trial. In this trial, it can be seen that five applications of sulfur over the season gave excellent

Continued on page 4

CA Pepper Commission

1994-95

Producer Representatives

Members		Alternates
	District 1	
Burt Silva King City 408/385-1428		VACANT
	District 2	
Frank Luenser Arroyo Grande 805/489-2508		Chris Darway Arroyo Grande 805/489-1817
	District 3	
Mike Mondelli Gilroy 408/847-1337		Tom Obata Gilroy 408/842-9809
	District 4	
Joe Marchini Le Grand 209/389-4528		Bob Giampaoli Le Grand 209/389-4576
	District 5	
Randy Johnston Lemoore 209/924-5339		Carl Lindgren Irvine 714/551-4103

Public Representatives

David Ferguson Fresno 209/435-6034	Ken McCorkle Fresno 209/441-5017
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Handler Representatives

Members		Alternates
	Bell Pepper Processors	
Don Nelson Calif. Veg. Conc. Modesto 209/538-5429		George Stuit Eckert Manteca 209/823-3181
	Dehydrated Chili Processors	
Paul Gniffke Universal Foods Greenfield 209/667-2777		Steve Banta Cal-Compak Foods Santa Maria 805/925-1908
	Other Pepper Processors	
Jerry Schwab Vlasic Foods Gilroy 408/848-4116		Glen A. Fischer Saticoy Foods Saticoy 805/647-5266
	Fresh Market Pepper Handlers	
Chuck Filice Denice & Filice Hollister 408/637-7491		Fred Podesta Jr. Podesta Farms Linden 209/887-3701
	Pepper Seed Handlers	
Ken Owens Petoseed Co. Woodland 916/666-0931		Robert Heisey Asgrow Seed Co. San Juan Bautista 408/623-4554

control of powdery mildew through most of the season. It should be mentioned that this site was sprinkler irrigated throughout the season which is known to also suppress powdery mildew on peppers to some degree. It is possible that the combination of the sprinkler irrigation and sulfur applications may have resulted in such good disease suppression.

At the San Juan Bautista site, the level of control in the sprayed portion of the field was not improved over the unsprayed area. The grower did have an excellent harvest from this field because the infection occurred late in the season. The Hollister site had a very slight infection from powdery mildew and no great difference was seen between the sprayed and unsprayed areas of the field. The level of disease in this field was low enough that no yield suppression was seen due to powdery mildew.

The data from the controlled experiments looks encouraging for the use of sulfur as a protectant material to control powdery mildew on peppers. The level of infection in these trials however, was low and no conclusive statements can be made from this data regarding the level of protection that sulfur will provide in heavy mildew infection years. The Hollister data indicates that sulfur applied at 5 lbs/A five times during the season did provide good control of powdery mildew, however the San Juan Bautista data is less encouraging. These observations were not made under controlled conditions and the dosage of sulfur applied was low - 1 lb/A. Nevertheless they do indicate that we should be cautiously optimistic about the beneficial effects of frequent applications of sulfur during the early to mid-season (flowering to mid-harvest) in suppressing powdery mildew on peppers. However, more studies are warranted to be able to make a general recommendation on the use of sulfur sprays to control powdery mildew to the entire pepper industry.

Detection of Curly Top Virus in Peppers and Screening Peppers for CTV Resistance

Robert Gilbertson, UC Davis
916-752-3163

CTV Detection We have determined that we can efficiently detect CTV in peppers, tomatoes, beans, sugar beets, and tobacco plants using the method nucleic acid squash blot hybridization and a CTV DNA probe. We received potential CTV samples from a number of areas around the state and also collected a number of samples as well. Leaf disks from these samples were squashed into nylon membranes along with uninfected plants and a probe consisting of cloned CTV DNA labeled with the radioisotope dAT³²P was added. After washing the membranes and exposing to X-ray film, the CTV-infected samples showed strong hybridization signals (black

spots corresponding to the squashed tissue print), whereas the uninfected plants showed no signals. It was very easy to differentiate infected from uninfected plants, and the test could be completed in 24-48 hours, depending on the urgency of needing the results.

The 1994 growing season was not a particularly bad CTV year for peppers as far as we could ascertain. In previous years CTV was severe on peppers in Monterey, Kings, Stanislaus, and Kern counties. However, in 1994 little CTV was found in peppers in Monterey and Kings counties and it was not a severe problem in Stanislaus or Kern counties. This is typical of CTV; some years it is worse than others and it is very hard to predict what years will be bad for CTV. *Result: Nucleic acid squash blot hybridization is an effective way to detect CTV in large numbers of plant samples.*

Characterize a CTV isolate from pepper and compare it to previously characterized CTV isolates. It is known that distinct CTV strains exist, but it is not known if these strains have a preference for certain hosts or if certain strains are associated with specific geographical regions. Because this is not known, it is important to work with a CTV isolate from pepper in developing a CTV infection system for pepper.

A CTV infected pepper plant was provided by Farm Advisor Jesus Valencia. The presence of CTV in this plant was confirmed by a squash blot hybridization analysis with a general CTV DNA probe. DNA was extracted from the infected pepper plant, and a portion (fragment) of the CTV DNA from this plant was amplified by the polymerase chain reaction (PCR) method using general PCR primers for geminiviruses. We successfully amplified the expected 800 base pair fragment (the entire size of the CTV DNA is about 3,000 base pairs) and cloned the fragment. The entire nucleotide sequence of the fragment was determined. We similarly amplified a CTV DNA fragment for beans infected with CTV collected from the Cuyama Valley. The sequences of these fragments were compared to each other and to those of two isolates that have been previously sequenced; one of these was from sugar beets in California (BCTV-CA) and the other was a hypervirulent isolate recovered from horseradish (CH1). The sequences of the CTV from pepper (CTV-pepper) and the bean CTV (CTV-bean) were very similar to each other (~96%), suggesting that they were isolates of the same virus. Interestingly, the sequences of CTV-pepper and -bean were much less similar to sequences of BCTV-CA, ~66%, or CH1, ~76%. These results suggest that a different curly top strain is infecting beans and peppers in California than the CTV strains that have been previously identified.

However, we can not say at this point whether certain CTV strains prefer pepper as opposed to beets, or whether the CTV-pepper is simply a predominant isolate in certain regions of California. We hope to learn more about the distribution of CTV-pepper in California peppers and other crops in the 1995 growing season. *Result: A new CTV strain infecting California peppers (CTV-pepper) was identified and partly characterized and a DNA probe is available for the specific detection of CTV-pepper.*