tion due to regression was highly significant.

It appears obvious that even when half of the casein protein (20% comfrey ration) was replaced with comfrey protein that there were drastic reductions in feed consumption (about 24%), feed conversion (about 50%) and gain (about 62%).

TABLE 1. PROXIMATE ANALYSES OF COMFREY AND CONTROL RATIONS (DRY MATTER BASIS)

| | Comfrey | | Control rations | |
|---|---|---|---|---|
| | Rat trial | Swine trial | Rat trial | Swine trial |
| | % | % | % | % |
| Crude protein | 26.0 | 24.4 | 10.3 | 17.6 |
| Ether extract | 2.4 | 3.4 | 3.9 | 1.2 |
| Crude fiber | 12.3 | 12.6 | 4.9 | 8.4 |
| Nitrogen-free extract | 35.7 | 35.9 | 77.4 | 67.1 |
| Ash | 23.6 | 23.7 | 3.5 | 5.7 |

TABLE 2. RATIONS, RAT TRIAL

| | Control | Comfrey | |
|---|---|---|---|
| | | 20% | 40% |
| | | Percenatge | |
| Casein | 11.0 | 5.5 | — |
| Comfrey, dehydrated | — | 20.1 | 40.3 |
| Corn oil | 5.0 | 5.0 | 5.0 |
| Sucrose | 71.4 | 60.1 | 48.7 |
| Cellulose* | 6.6 | 3.3 | — |
| Salt mixture† | 4.0 | 4.0 | 4.0 |
| Vitamin mixture‡ | 2.0 | 2.0 | 2.0 |

* Solka-floc.

† Salt mixture P-H manufactured by Nutritional Biochemical Corporation, Cleveland, Ohio.

‡ Vitamin Diet Fortification mixture manufactured by Nutritional Biochemical Corporation, Cleveland, Ohio.

TABLE 3. RESULTS, RAT TRIAL (21 DAYS, 10 RATS PER GROUP)

| | Ration | | |
|---|---|---|---|
| | Control | Comfrey | |
| | | 20%† | 40% |
| Final weight, gm. | 107.4 | 68.4 | 36.9 |
| Initial weight, gm. | 42.8 | 43.7 | 44.2 |
| Gain, gm. | 64.6[a,*] | 24.8[b] | –7.3[c] |
| Feed comsumption, gm. | 212.6[x] | 161.9[y] | 135.1[z] |
| Feed per unit gain | 3.36[a] | 6.77[b] | — |

* Values on same line differ significantly from those with different superscripts—a, b, c ($P < 0.01$); x, y, z ($P < 0.05$).

† One rat succumbed on day-6 of this ration. Data based on nine rats fed the 20% comfrey ration.

TABLE 4. RATIONS,* SWINE DIGESTION TRIAL

| | Control | Comfrey | |
|---|---|---|---|
| | | 20% | 40% |
| | | Pounds | |
| Ground barley | 83 | | |
| Cottonseed meal (41% CP) | 11 | | |
| Meat and bone meal (50% CP) | 6 | | |
| Salt | 0.5 | | |
| Control, above | | 80 | 60 |
| Ground, dehydrated Comfrey | | 20 | 40 |

* Plus 1675 I.U. Vitamin A and 90 I.U. Vitamin $D_2$ per pound of ration.

TABLE 5. RESULTS OF SWINE DIGESTION TRIAL (3 × 3 Latin square)

| | Coefficients, apparent digestibility | |
|---|---|---|
| | Control ration | Comfrey* |
| | % | % |
| Crude protein | 73.7 | 49.6 |
| Ether extract | 26.5 | 80.3 |
| Crude fiber | 14.9 | 84.5 |
| Nitrogen-free extract | 83.2 | 66.5 |
| Calculated total digestible nutrients (TDN, %) | 70.8 | 52.7 |

* Calculated by difference between the control ration and the 20% and 40% comfrey rations.

A 3 × 3 Latin square design digestion trial was run with rations also containing 0, 20 and 40% dehydrated comfrey (rations in table 4, analysis of comfrey and control ration, table 1) and three pigs weighing initially about 80 lb and finally about 140 lb. Collection periods were 10, 10 and 9 days and feed consumption 4, 5 and 6 lb in each of the three periods, respectively. The results are summarized in table 5. The digestion coefficients indicate a calculated TDN content of 52.7% for the comfrey used in this trial.

## Swine rations

Analyses of variance were calculated for apparent coefficients of digestibility of the three swine rations for the organic components of the proximate analysis. In spite of the low magnitude of the degrees of freedom, the differences for the coefficients of digestibility between rations were statistically significant for crude protein ($P < 0.05$) and crude fiber ($P < 0.01$). The differences in coefficients for ether extract approached significance at the 5% level, but they lacked statistical significance for the nitrogen-free extract (NFE) because of variation caused by significant pig ($P < 0.05$) and period (replicate) ($P < 0.01$) effects. If the coefficients for NFE for pigs fed the control, and 20% comfrey, rations were combined and compared with those for pigs fed the 40% comfrey ration, analysis of variance indicated a highly significant difference. The coefficients of digestibility showed significant changes between comfrey levels due to regression for crude protein and crude fiber ($P < 0.01$) and ether extract ($P < 0.05$). Regression coefficients were positive for ether extract and crude fiber indicating that the digestibility of these components was higher in comfrey than the basal ration, but the reverse was true for crude protein and NFE where the regression coefficients were negative.

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*Hubert Heitman, Jr. is Professor, Department of Animal Science, University of California, Davis, and Sergio E. Oyarzun, graduate student, is now Associate Professor, Swine Husbandry, University of Chile, Santiago.* *Financial support was received from the Chevron Chemical Co., San Francisco. Milton D. Miller, Extension Agronomist, supplied the dehydrated comfrey and assistance was received from James T. Elings, Extension Animal Scientist, and Bob D. Wilson, summer working student who assisted with the rat trial.*

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F. M. SUMMERS

# *Relationship of NAVEL ORANG to hard*

THERE ARE SEVERAL severe bottlenecks in the search for agricultural chemicals (toxicants, sterilants or repellents) to control navel orangeworm infestations in almond orchards. One is that the use of experimental or unregistered pesticides jeopardizes the sale of crops from test plots. Another concerns the scarcity of knowledge about the flights of moths within or between orchards and within entire communities. The tools to do this kind of assessment work are still crude and the manpower requirement is high. Individuals and various small research teams working in California have accumulated a large amount of information about this tenacious pest, but an economic control method for orchard infestations has not yet been determined.

## Bioassays

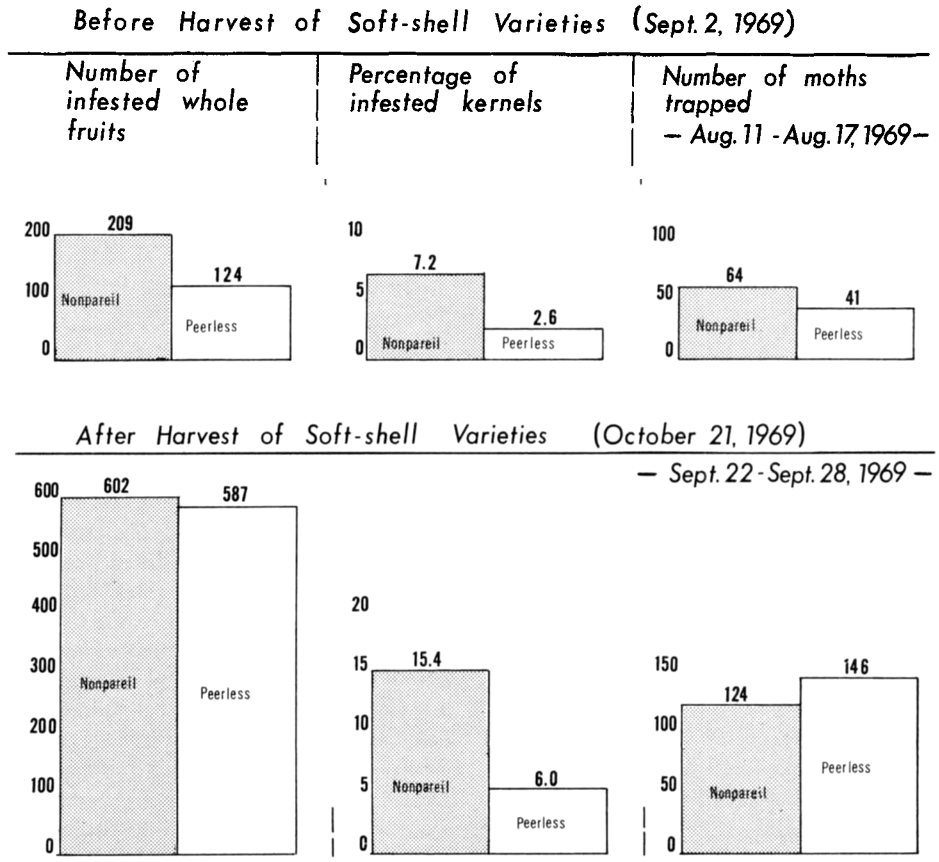
Bioassays of various pesticide effects against moths and larvae seem to show that the individual active stages of this pest are not particularly immune or resistant. However, repeated applications of potent and persistent pesticides applied to protect ripening crops fail to give the result desired. The supposition is that the true value of treatments in small plots is not evident because there is an inflow of moths from surrounding untreated areas. The moths flying into an area inflict additional damage before the pesticide residues begin to act, making it impossible to find out how a treatment affects the original inhabitants of a test plot. The result is a lack of knowledge on how large a treated area must

# EWORM MOTHS

# shell and

# soft shell almonds

NUMBERS OF NAVEL ORANGEWORM STAGES IN SOFT-SHELL (NONPAREIL) AND HARD-SHELL (PEERLESS) VARIETY ALMOND TREES AND FRUIT, BEFORE AND AFTER HARVEST OF THE SOFT-SHELL VARIETY FRUITS




be in order to sustain the benefit of an applied control.

One segment of knowledge which is relevant to this problem concerns the relationship of the moth stage of the pest to varieties of trees which bear soft-shell and hard-shell almonds. Since the hard-shell nuts resist attack by larvae of the species, do the egg-laying moths avoid these trees? Experimentation would be simplified if trees bearing true hard-shell nuts could be ignored, i.e., left untreated without appreciably affecting results of tests applied to the interplanted but more susceptible soft-shell varieties.

### Distribution

During 1969 attempts were made to get information on how navel orangeworm moths distribute themselves among trees which bear soft-shell (more susceptible) and hard-shell (less susceptible) nuts. Samplings of moths and almond fruits were taken twice from trees of two varieties—Nonpareil and Peerless—during the harvest period when infestations begin to increase rapidly. The first round of moth trapping was done during the period of August 11 to 17, approximately the period of beginning hull split for Nonpareils. A second round of moth trapping was done during the period September 22 to 28, after Nonpareils were harvested but before Peerless nuts were harvested in the test orchard.

The initial nut samples were taken on September 2, the second on October 21. In the latter case, the nuts from Nonpareil trees were trash nuts which knockers failed to dislodge. Moths were captured in liquid traps baited with emulsified phenyl proprionate, 10 traps for each variety operated six days during each interval. Almond whole fruits (1250 nuts from 25 or more trees of each variety) were minutely examined for evidence of moth visits—the presence of eggs, larvae, pupae or shells and remnants thereof.

The data obtained in the before-and-after samplings showed: (1) increases in number of whole fruits showing one or more immature stages of the pest—Nonpareil 209 to 602 (×2.9), Peerless 124 to 587 (×4.8); (2) increased percentages of infested kernels—Nonpareil 7.2 to 15.4 (×2.1), Peerless 2.6 to 6.0 (×2.3); and (3) increases in total moths trapped in six days—Nonpareil 64 to 124 (×1.9), Peerless 41 to 146 (×3.6).

The principal conclusions based on observations in this orchard are as follows: (1) moths, eggs, etc., were more prevalent in these Nonpareil trees than in the companion Peerless trees when full crops of ripening nuts were present in both; (2) after Nonpareils were harvested but before harvest of Peerless nuts, the prevalence of moths and the numbers of whole fruits showing evidence of one or more immature stages tended to equalize for the two varieties even though the percentage of worm-damaged hard-shell meats remained comparatively low; (3) Peerless nuts were not entirely immune to attack, and between September 2 and October 21, 1969, the quantity of wormy kernels of the hard-shells increased to 6 per cent. This change in worm-damaged Peerless kernels was not proportionately higher than the increase in worm-damaged Nonpareil kernels. According to these data it would not be feasible to disregard trees of hard-shell varieties in studies of orchard infestation trends, or in treatment plots.

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