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Almond Board Project No. 81-I3: Modelling Population Dynamics
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Model Status: Developmental work on the navel orangeworm computer simulation model over the past season has included the addition of standardized file handling routines for input and output; the implementation of separate varietal tracks for insect development; the implementation of crop management practices of spraying, knocking, and cleanup; and a preliminary attempt to monitor the changing levels of nut density and crop infestation. The interactive input/output structure now has the following features:

(1) User Input
   (a) Daily maximum/minimum temperatures for the calendar period of interest;
   (b) Orchard parameters, to include: number of trees per acre, varietal (soft-shell) mix of the planting, dates of last harvest, average sticktight density after last harvest; and estimates of the current crop hullcrack dates and average yield per tree;
   (c) Insect development and survival parameters; best estimate values are provided by default if the user has none of his own;
   (d) Start date for the simulation and the initial state of the population, from mummy-crack or egg-trap samplings.

   All input information is read in from data files which the program allows the user to create, to display on the screen, or to load into the model.

(2) User Options
   (a) Simulation of crop management practices, to include the insertion and timing of insecticide sprays (larvacidal or adult-effective), winter knocking and/or cleanup, harvest knocking and sweeping;
   (b) Choice of the type, timing, and format(graphical/tabular) of output results.

(3) Program Output

   Graphical or tabular displays of the Julian date of the output samples; the heat units accumulated from start time to date, above a user-specified temperature threshold; insect population profiles, classified by insect stages and separated into Nonpareil,pollinator, or ground mummy developmental tracks; simulated egg-trapping samples (if desired); density of Nonpareil and pollinator nut crops; percent infestation of Nonpareil and pollinator nuts. Samples of tabular output, as they appear on the screen or in a printout, are shown on page 2.

IPM Use: We feel that development of our TERAK microcomputer version of the model is now essentially complete. At the same time, work has continued on modification of the programming syntax and I/O features to create a version which would be compatible with the PRIME computers of the statewide IPM network. Four weeks ago we requested and received a Research account on this network so that the results could be tested. We now have it running, although many of the features of the microcomputer model are not yet operational on the IPM network version. Once the transfer is complete, and after some testing, we shall present the program to the IPM Almond Work Group for modification advice, and permission to make it available in a Test Mode on the system.

Validation Studies: Two orchards have been monitored on a continuous basis over the last season,with some results still coming in. There has not yet been time to properly analyze these data and make the comparisons with computer simulations. This work will be continued over the next months as part of the preparation of the model for IPM network approval.

Samples of Model Output

TIME = 30.00 DEG-DAYS(above 55.0 from t= 0.0)= 21.7

INSECT POPULATION STATISTICS(per acre)

Stage	NPnuts	Pollnuts	Groundnuts	Total
Eggs	0.0	0.0	0.0	0.0
Larvae	213.0	70.0	2.6	285.6
Pupae	3.2	1.2	0.0	4.0
Adults	*	*	*	0.0

DETAILED LARVAL INSTAR AND PUPAL STATISTICS

Instar	NP	Poll	Ground	Total	Pupae	NP	Poll	Ground	Total
1	0.0	0.0	0.0	0.0	Light	1.5	0.5	0.0	2.0
2	20.9	6.9	0.2	27.9	Dark	1.5	0.5	0.0	2.0
3	58.1	19.1	0.6	77.8					
4	56.6	18.6	0.7	75.9					
5	0.0	0.0	0.0	0.0					
6	77.4	25.4	1.2	103.9					

CROP AND INFESTATION STATISTICS(per acre)

Nuttype	Nuts	% Damaged
Nonpareil	1.14335E3	41.00
Pollinator	3.75548E2	41.00

TIME = 160.00 DEG-DAYS(above 55.0 from t= 0.0)= 1055.6

INSECT POPULATION STATISTICS(per acre)

Stage	NPnuts	Pollnuts	Groundnuts	Total
Eggs	149.6	49.1	0.0	198.8
Larvae	2037.5	669.2	204.8	2911.5
Pupae	0.0	0.0	0.0	0.0
Adults	*	*	*	9.9

DETAILED LARVAL INSTAR AND PUPAL STATISTICS

Instar	NP	Poll	Ground	Total	Pupae	NP	Poll	Ground	Total
1	378.2	124.2	8.4	510.9	Light	0.0	0.0	0.0	0.0
2	517.8	170.1	32.0	719.8	Dark	0.0	0.0	0.0	0.0
3	648.2	212.9	66.4	927.6					
4	491.0	161.3	97.2	749.5					
5	2.3	0.8	0.8	3.9					
6	0.0	0.0	0.0	0.0					

CROP AND INFESTATION STATISTICS(per acre)

Nuttype	Nuts	% Damaged
Nonpareil	4.82298E2	99.64
Pollinator	1.56414E2	99.64

TIME = 200.00 DEG-DAYS(above 55.0 from t= 0.0)= 1353.9

INSECT POPULATION STATISTICS(per acre)

Stage	NPnuts	Pollnuts	Groundnuts	Total
Eggs	4824.8	3446.3	0.0	8271.1
Larvae	4413.7	4451.4	147.5	9012.6
Pupae	539.8	177.3	107.3	824.4
Adults	*	*	*	641.0

DETAILED LARVAL INSTAR AND PUPAL STATISTICS

Instar	NP	Poll	Ground	Total	Pupae	NP	Poll	Ground	Total
1	4013.4	4275.9	37.9	8327.1	Light	62.5	20.5	13.2	101.2
2	2.1	44.7	1.2	48.0	Dark	477.4	156.8	89.0	723.2
3	0.2	0.0	0.0	0.0					
4	0.2	0.8	0.0	0.0					
5	74.6	24.5	16.8	115.9					
6	323.5	186.3	91.7	521.6					

CROP AND INFESTATION STATISTICS(per acre)

Nuttype	Nuts	% Damaged
Nonpareil	6.51654E4	9.34
Pollinator	3.82383E4	12.61