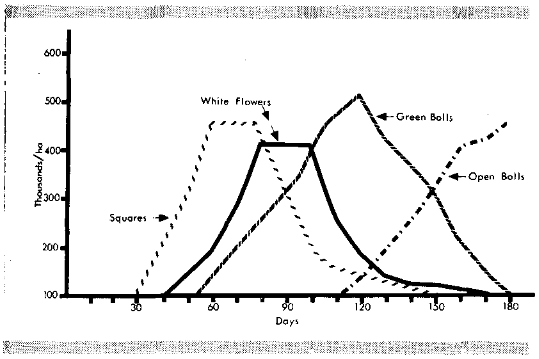

Seasonal growth of flowering and fruiting parts of cotton plant. Graphs such as this can show number of fruiting parts "at risk" at any time of season and can give an estimate of yield.

relation to climate, insect populations, irrigation, fertilization, cultivation, and, to some extent, disease. The pest management advisor or grower visits fields at frequent intervals from mid-May until the end of September, where he measures plant growth, notes fruiting performance, assesses insect populations (both noxious and beneficial), records pest injury, and notes weather conditions and crop production practices (*e.g.*, irrigation, cultivation, fertilization). At the same time, he plots actual crop performance and compares it to optimum performance for the Acala variety under cultivation. Deviations from optimum performance call for an assessment of the spectrum of factors that might be hampering plant performance. This takes much of the guesswork out of pest control decision-making. In San Joaquin Valley cotton, insects have too often been blamed for crop loss when poor agronomic practices, or adverse weather conditions, have been the cause.

Economic thresholds

Under the integrated control program the guesswork about insect injury has been even further reduced by refined economic thresholds (the point at which insect injury is sufficient to justify artificial control measures) for lygus, bollworms, and the defoliating caterpillars.

For example, the refined lygus economic threshold restricts spraying for the pest to the early season (usually the month of June), and to the few fields where the pest becomes sufficiently abundant to pose a threat. As a result, there has been a reduction in overall spraying for lygus in San Joaquin Valley cotton, and a strong reduction of mid-season spraying. Spray costs are therefore lower, lygus control is more efficient, and the bollworm has virtually disappeared as a secondary outbreak pest.

Through integrated control, the bollworm, the most severe insect pest of cotton in the 1960s, is no longer an economic problem in the San Joaquin Valley. Furthermore, the integrated pest control program permits the grower to use the organophosphate substitutes for DDT in an efficient and nondisruptive way. Finally, there has been a benefit to the general environment, which now receives a substantially lower pesticide load under the integrated control program.

The future

Research on integrated control in San Joaquin Valley cotton continues. For example, a refinement of the lygus economic threshold has been developed: the static ten bugs per 50 net sweep threshold has been replaced by a flexible number which relates lygus density (as determined by sweeping) to square load (number of squares per acre). Under this system, as square load increases, so does the number of lygus that can be tolerated.

Intensive studies of spider mites, the one pest group that has until now been poorly understood, are under way. Already considerable light has been shed on the phenologies of the three spider mite species, their in-field and on-plant distributions, their damage potentials, their natural enemies and their artificial control. A tangible benefit has been the development of a rapid and efficient spider mite sampling method.

Finally, the cotton plant model is adding insight into cotton performance and is already helping to refine the existing integrated control program into a scientifically reliable, highly sophisticated pest management system.

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HEAT ACCUMULATION METHOD AIDS COTTON PEST MANAGEMENT

A heat accumulation method of predicting pest outbreaks has proved simple, practical, and efficient in the management of two pests of cotton—lygus bug and pink bollworm.

By totaling heat units based on daily maximum and minimum temperatures, starting January 1, researchers have gathered data permitting accurate prediction of pink bollworm emergence and of lygus bug movement from safflower into cotton. The latter prediction has enabled California growers to apply a single, areawide insecticide application, largely eliminating the lygus bug threat in the San Joaquin Valley for the remainder of the growing season. The forecasting system also accurately predicts pink bollworm overwintering, emergence, and subsequent generation peaks in Imperial and Palo Verde valleys.

The thermal accumulation method depends upon three factors in the calculation and accumulation of heat units: the temperature threshold(s) for the development of the organism; the relevant period in its life cycle; and the method(s) of calculating the heat units.

Most weather stations keep records only for daily maximum and minimum temperatures. Therefore, a practical heat summation method requires only those values. The daily maximum and minimum temperatures, when checked against a computer-produced table, can be expressed as degree-days. It was found that 50 percent of the pink bollworm population emerges at the accumulation of about 13,600 degree-days. Peak emergence occurs at about 16,200 degree-days. Subsequent generations appear in predictable peaks about 35 to 40 days apart, depending on prevailing temperatures (or 23,200 degree-day intervals from peak emergence).

Similar prediction methods are being developed for monitoring the growth of the cotton plant and for cabbage looper and lettuce root aphids on lettuce.

Heat accumulation techniques in pest management are not only simple and practical but lend themselves admirably to computer technology and analytical methods already available and in use.

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