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AN INITIAL EVALUATION OF BIOLOGICAL AND CULTURAL CONTROLS OF TARO PESTS IN AMERICAN SAMOA

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ABSTRACT

Taro, *Colocasia esculenta*, a staple crop in American Samoa, was found to serve as a plant host to several potentially devastating insect pests: the taro armyworm, *Spodoptera litura* (F.); the taro hornworm, *Hippotion celerio* (L.); the taro, or melon aphid, *Aphis gossypii* Glover; and the taro planthopper, *Tarophagus proserpina* (Kirkaldy). Sixty taro plants were observed weekly over a 7-month period in 1985 and 1986. *Apanteles sp., Euplectrus sp.*, and *Chelonus sp.* were found parasitizing *S. litura* on these plants. A hymenopteran parasite, a ladybird beetle, and a syrphid fly larva were biological control agents found in association with the taro aphid. *Cyrtorhinus fulvus* Knight preyed on eggs of the taro planthopper. A population study of the taro planthopper yielded a negative binomial distribution. An extract of diseased *S. litura* larvae was as effective as Dipel (*Bacillus thuringiensis*) in causing taro armyworm mortality in a laboratory trial. Intercropping taro with *Coleus blumei* had no measurable effect on taro armyworm incidence.

Taro, *Colocasia esculenta* (L.) Schott, a member of the Araceae Family, is an ancient crop grown throughout the tropics and subtropics for its edible corm. It is the major staple crop in American Samoa. Little is known regarding insect pest species on this crop or related biological controls in American Samoa. Planting *Coleus blumei* Benth ("pate" in Samoa) with taro is a local practice which farmers believe decreases numbers of taro armyworms, *Spodoptera litura* (F.), in intercropped fields.

This study was conducted to determine which insect species were present on taro, assess their associations with the crop, and determine the effectiveness of intercropping *C. blumei* with taro to control the taro armyworm.

Materials and Methods

Intercropping study. A 550 m^2 plot was laid out in a completely randomized design with four treatment combinations: Niue and Manua taro cultivars planted in the presence and absence of *C. blumei*. Each treatment combination was replicated twice. There were between 81 to 99 plants per treatment combination. Once or twice a week, beginning 4 days after planting, 8 plants were randomly selected from each treatment combination, and the types and number of insects on each plant were recorded. In all, 33 such samples were taken over a 22 week survey period. Counts or careful estimates (of highly mobile insects) were tabulated for 4 specific pests: taro armyworm, *Spodoptera litura* (F.); taro planthopper, *Tarophagus proserpina* (Kirkaldy); taro hornworm, *Hipption celerio* (L.); and taro aphid, *Aphis gossypii* Glover. Because estimates of taro planthopper numbers could exceed 1000 insects $plant^{-1}$, their populations were grouped into cells of 50 and an integer assigned for each cell. For example, a sample having 0 to 49 planthoppers per plant was assigned the value of 0; 50 to 99 planthoppers per plant was 1; and so forth up to 20, which represented 1000 or more planthoppers per plant. Counts of *Cytorhinus fulvus* Knight, an egg-piercing mirid predator of the planthopper, were also recorded. To detect parasites of the taro armyworm, larvae were randomly removed from the field, isolated in vials, and closely monitored for parasite emergence.

Insect pathogen study. To study what appeared to be a naturally occurring taro armyworm disease, an experiment was undertaken when several diseased armyworms, characterized by their bloated and discolored appearance, were noted in the field. Ten to twelve containers holding 10 to 15 first- and second-instar larvae were set up to receive each of the following treatments: Dipel (*Bacillus thuringiensis* var. kurstaki); diseased insect spray; and a water control. For the diseased insect spray, two infected armyworms were ground in a blender with 70 ml of water. The liquid was decanted and about 0.5 ml was sprayed on the larvae in each container. Mortality data was collected over 4 days.

Results and Discussion

Intercropping study. Three genera of parasites emerged from taro armyworm larvae: *Apanteles sp.*, *Euplectrus sp.*, and *Chelonus sp.* The armyworm is occasionally a serious pest of taro in American Samoa. In our case it was not so. Possibly, environmental conditions were not conducive to the reproductive cycle of the armyworm or perhaps the biological control complex present in this area, where no pesticides had been used, was sufficient to hold pest populations in check.

Analysis of variance indicated no significant differences in taro armyworm populations between plots intercropped with *C. blumei* and those which were not. As indicated above, armyworms were not considered a serious problem at this time. In 66% of the 2012 sample counts, no armyworms were found. Although leaf damage was not measured quantitatively, overall observations and local opinion indicated that damage was negligible.

The taro planthopper was often found in large numbers on taro along with the mirid predator *C. fulvus* (Fig. 1). Both insects were found together in young, unfolded taro leaves and all leaf petioles. Leaves with high planthopper infestations (> 1000 individuals $leaf^{-1}$) turned yellow, often with the entire petiole rotting. However, there was no evidence of alomae and bobone, two viral diseases transmitted by the planthopper. Fluctuations in the prey and predator populations appeared to follow a typical biological control scenario where an increase in the prey, *T. proserpina*, population is followed by an increase in the predator, *C. fulvus*, population (Fig. 1). After day 75, the increase in the *C. fulvus* population corresponded to a leveling off of the planthopper populatio-

n. The population dynamics of this complex suggests that *C. fulvus* is actively suppressing the taro planthopper.

One step in the integrated pest management approach to controlling pests is devising a sampling method which will allow farmers to determine when to apply pesticides. The population distribution of the pest must first be determine. The model that best fitted our grouped and transformed data with better than a 99% confidence interval was the negative binomial distribution (Fig. 2). This implied that our methods of sampling and estimation were accurate and reliable. The deviation from the curve in cell 20 suggests that errors in estimation are more likely to occur when large numbers of planthoppers are present. In the future, this mathematical model will be used, along with yet to be determined economic thresholds, in the development of a sequential sampling method to assist in taro planthopper control.

The taro hornworm and the taro aphid were occasional pests. Ladybird beetles, syrphid fly larvae, and parasitic wasps appeared to keep the aphid population in check. Species identification of these natural enemies is underway.

Insect pathogen study. An evaluation of the insect disease experiment showed that mortality in the Dipel and the dead-insect spray groups were significantly different ($P = 0.01$ level) from the control, or water group. There were no significant differences between the Dipel and the dead-insect spray group. Mean percent mortalities after 4 days were 75, 83, and 46% in the Dipel treatment, dead-insect spray treatment, and control, respectively (Fig 3). The occurrence of this disease may be another factor in the low incidence of armyworms observed.

Conclusions

In American Samoa, taro appears to be an ideal crop in consideration of the pest and biological control complexes present. Additionally, a naturally-occurring taro armyworm disease appears to suppress the taro armyworm population. *C. blumei*, intercropped with taro, did not significantly reduce taro armyworm numbers in our plots. However, its true effects may be masked because the armyworm population was low during the experiment. Additional studies are necessary to determine its role as well as the roles of seasonality, rainfall, and other abiotic factors.

Taro planthopper can occur in large numbers, causing mechanical damage. Its mirid predator, C. *fulvus*, appears to be an effective biological control. Study of the population dynamics of the planthopper yielded a negative binomial distribution. Additional studies are necessary to determine economic thresholds for this pest.

References

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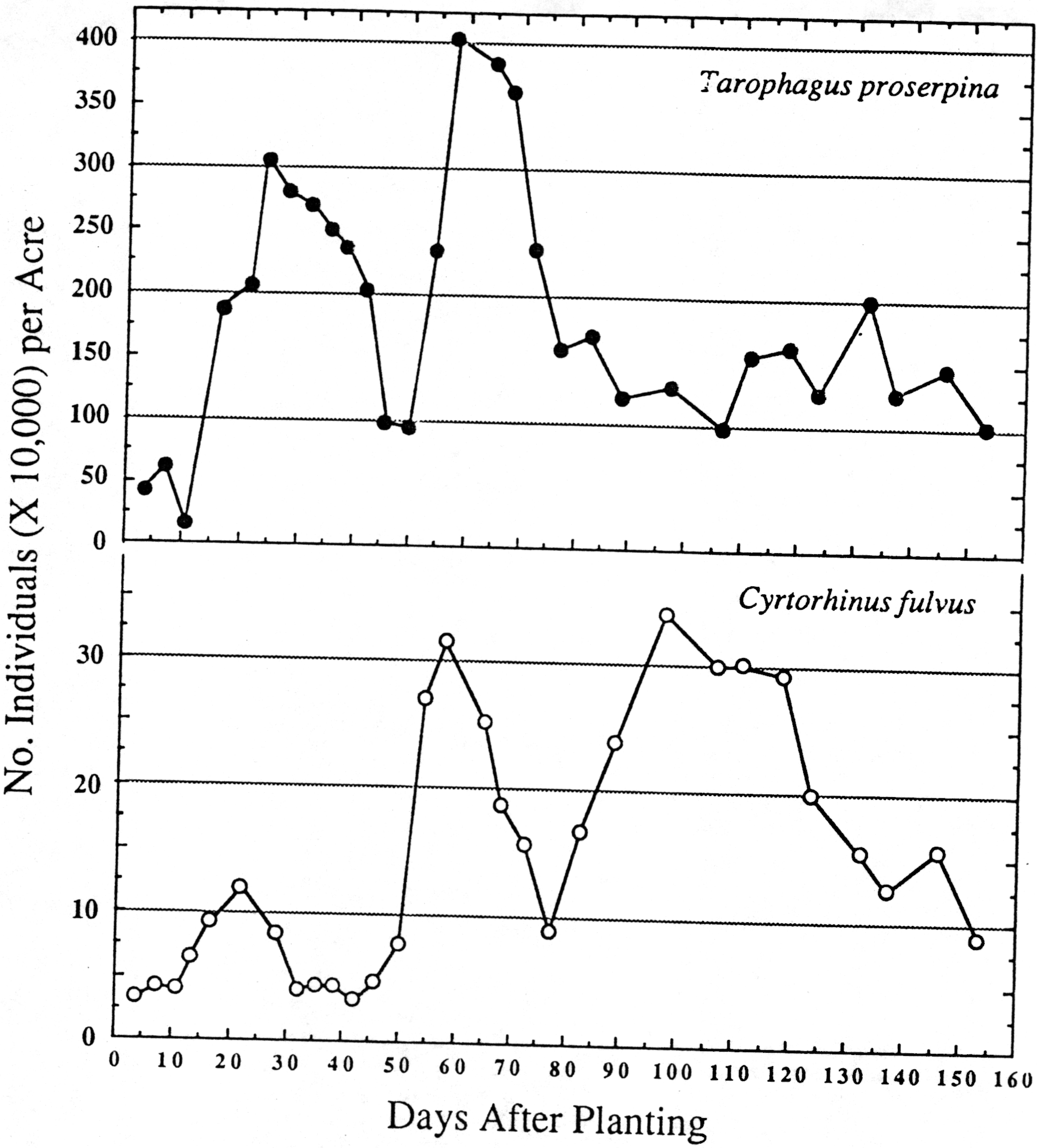

Fig. 1. Comparison of densities of the taro planthopper, *Tarophagus proserpina*, and the egg-piercing mirid predator, *Cytorhinus fulvus*, in a taro field.

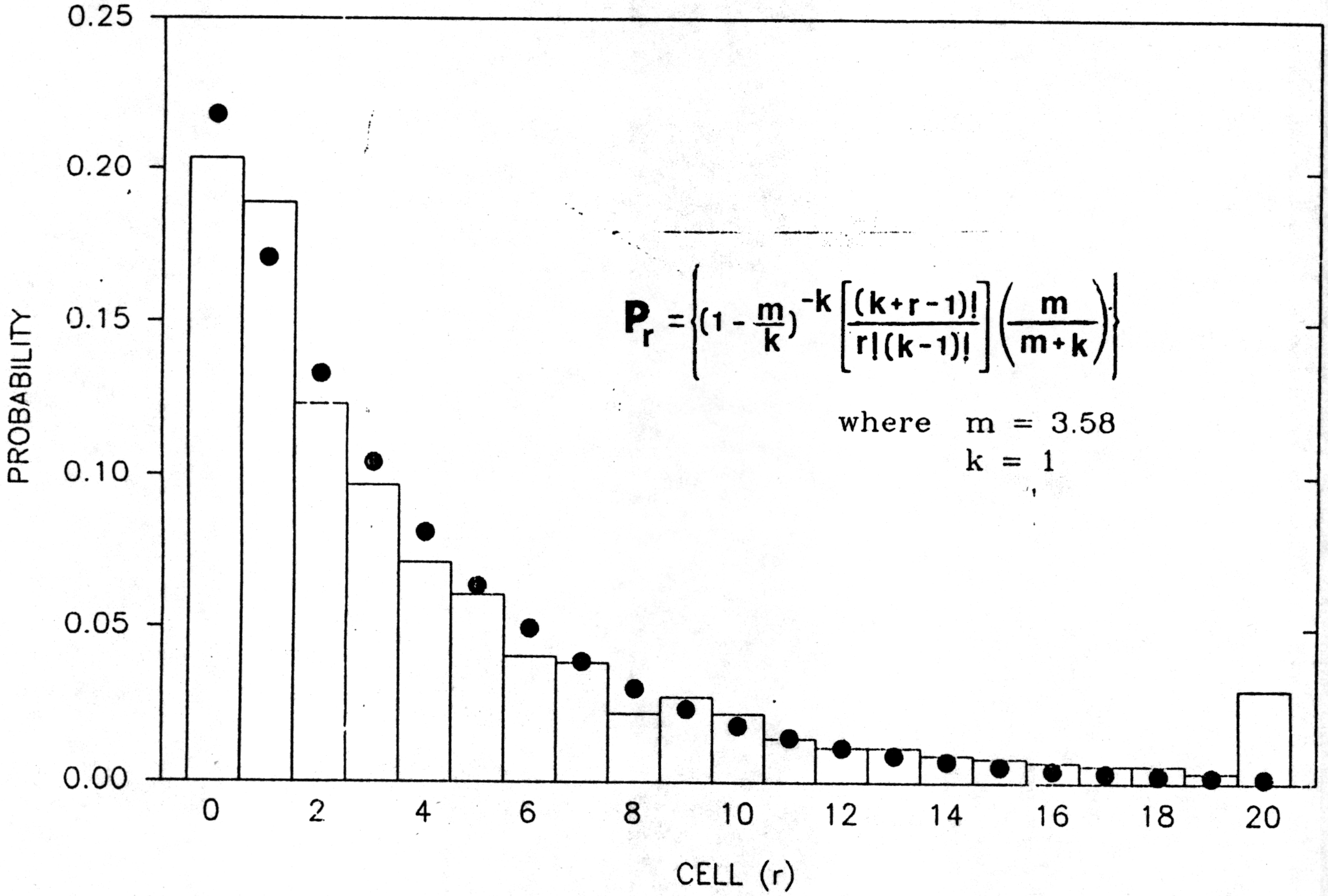

Fig 2. **Negative binomial distribution of the taro planthopper, *Tarophagus proserpina* on Niue and Manua cultivars of taro, *Colocasia esculenta* (L.) Schott.** The number of individual planthoppers were counted or estimated per plant and grouped in multiples, or cells, of 50. The bars depict actual probabilities; the circles were calculated from the negative binomial distribution equation.

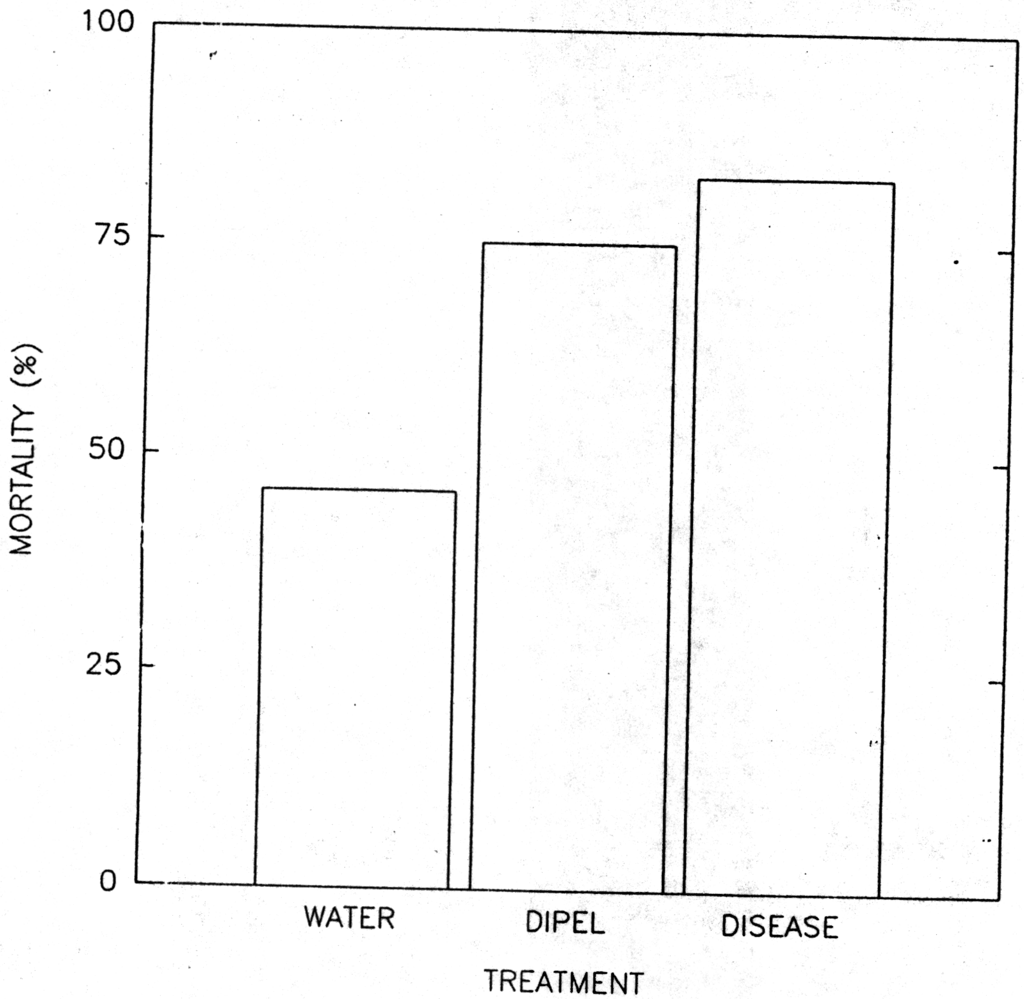

Fig 3. The effectiveness of a solution prepared from the bodies of diseased taro armyworms, Spodoptera litura, larva. The mean percent mortalities 4 days after treating apparently healthy armyworms with either water, Dipel, or the solution prepared from the diseased worms are, respectively, 46, 75, and 83%.