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NEW DIRECTIONS AND DEVELOPMENTS IN SHADE TREE ENTOMOLOGY[1]

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In keeping with the theme of the convention - "Fifty Golden Years and Growing" it is most appropriate that we anticipate the upcoming challenges in shade tree pest control. Several factors may influence our actions, but major changes will be dictated by two recent developments. The attitudes toward pesticides which spawned the enactment of the Federal Environmental Pesticides Control Act (FEPCA) in the United States in October 1972 and demands worldwide for non-chemical pest control alternatives will be the driving forces for at least the next decade.

The practicing arborist or plant protection specialist finds himself confused by the practicality of initiating or implementing new insect control techniques and threatened by impending regulations and legislation. It is my intent to present to you my interpretation of these new developments and the directions in which shade tree insect programs will probably evolve.

To place this discussion of these new developments in proper perspective, consider this— in the U.S. there are fewer than 25 researchers working on insects of shade trees and shrubs (Weidhaas 1972). Contrast this to other "more economic" crops such as cotton, corn, fruit trees, etc., where there may be as many as 100 entomologists working on one insect on one crop. This may necessitate the adaptation of procedures developed for other crops to suit our specific needs. While there is nothing inherently wrong with this concept, there always is the problem of incompatibility between different insects under different ecological systems.

People no longer accept the use of pesticides as the only solution to their insect problems. Fortunately there are few continuous major problems on shade trees. Most of our native insects are held at low levels by natural controls but periodically flare up necessitating remedial treatment. Shade trees then offer a great opportunity to utilize the biological with physical and chemical controls in what has recently been popularized as Integrated Control. I'm sure that many municipal foresters, arborists and others in pest control have been asked, "Why haven't you attempted biological control?" or "Can biological control be used on my trees, city trees, or in parks, instead of chemicals?"

There are many widely held feelings about biological control and its practicality or potential. I feel that in order to implement a true biological control program each pest must be considered separately and its potential for satisfactory control by native or introduced parasitoids and predators must be carefully established. Immediately you might think that's impractical; I don't have the time, money or expertise to attempt such a program! Then do we ignore integrated or biological control? Obviously not. But let's not just give it lip service by suggesting it for use by individual homeowners, arborists or municipalities without first determining its practicality and developing bio-control strategies and procedures.

Perhaps the most over-used example of suc-

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cessful biological control has been the control of the cottony cushion scale, *Icerya purchasi*, by the vedalia beetle, *Rodolia cardinalis*. Many people employ this as the first and last example of biological control, a fact which is simply not so. While not all biological control attempts have been as successful, there are reasons to be optimistic. According to DeBach (1972), from 1888 to 1969, there were throughout the world 42 complete successes, and 120 initial successes out of attempts to control some 223 insect species.

The majority of these successes were against aphids and scales, groups of insects which are continual shade tree pests. Several might be mentioned but I would draw your attention to the San Jose Scale, *Aspidiotus perniciosus*, which used to be a severe pest on quince, plum, ash, dogwood, elm and other trees and ornamentals. According to Sailer (1972) the introduction of the parasite *Prospaltella perniciosi* from the Orient has led to its demise. Today it is extremely difficult to find this pest causing serious damage. In a recent study aphids were the principal pest successfully manipulated in the integrated control program developed for the city of Berkeley, California's 30,000 trees.

According to Olkowski, et al. (1974) the use of synthetic chemical insecticides was reduced significantly by utilizing imported parasitoids, chemical and biological sprays and physical manipulations viz. high pressure water sprays, adhesive bands, etc. This program was geared toward the biological control of three aphids (*Eucallipterus tiliae, Tinocallis platani,* and *Tuberculoides annulatus*) with imported parasitoids. Special insecticide treatments were necessary to control the calico scale, *Lecanium cerasorum*, and *Bacillus thuringiensis* was used to control the California oakworm, *Phyraganidia californica*. As a direct result the city reported pesticide savings of $22,500 per year from reduced numbers of sprays by eliminating treatments on a calendar basis, and complaints from residents have been reduced.

Not all shade tree problems can be handled in this fashion because of the variation in pest as well as beneficial species. Furthermore, even vigorous attempts on a large basis may witness limited success. For example, large scale releases of parasitoids and predators to control Gypsy moth, while giving some suppression, have not eliminated this insect. This reinforces the fact that in Europe, Asia and Africa where this insect is native it still poses periodic problems. It is unkown if we can satisfactorily suppress this insect with natural enemies. Hence, the use of integrated control approaches with a pest management philosophy is now considered the primary method of dealing with the Gypsy moth.

In another instance what may have appeared as a futile attempt to establish *Dendrosoter protuberans*, a parasite of the smaller European elm bark beetle, *Scolytus multistriatus*, may prove successful. Following the importation by the USDA, and biological studies establishing that it was environmentally compatible, releases were made in 1965 in various Michigan locations. Subsequent research and survey during a 5 year period by Truchan (1970) indicated that its establishment was questionable. Elm bark thickness was believed to be the limiting factor since *D. protuberans* could not oviposit and reach the cambium where *S. multistriatus* larvae feed when the bark thickness exceeded ½ inch. During 1973 surveys of bark beetle parasites by personnel of the U.S. Forest Service, Delaware Ohio laboratory determined that its numbers and distribution are increasing in Detroit (Kennedy and Roberto 1974).

The antithesis of importation of biological control organisms is the introduction of detrimental species. According to Kennedy (1974) the hyperparasite *Cercocephala rufa* which attacks *D. protuberans* was also found and appears to be established in Michigan. This reinforces the very important fact that biological importation and manipulation must be carefully screened and evaluated before it is initiated to prevent deleterious side effects.

While many of us must, for obvious reasons, consider our pest problems in our own narrow geographic area, town, park, homeyard, etc. there is evolving the concept of regional pest management in unison with environmental monitoring. This is currently being attempted on agricultural crops and it appears that its implementation will be useful against other insects including shade tree pests and their natural controls on a multi-state or regional basis.

Recent work at Michigan State University (Fulton and Haynes 1974) has utilized computer mapping of insect activity and coordinated it with on-line weather. This computerized on-line weather system provides the capability of utilizing models to predict the biological activity of the pest species (to more accurately anticipate controls), and parasitoids and predators (to apply control strategies within the window having the least detrimental effect upon beneficial species) and degradation rates of pesticides. We are currently attempting to establish the relationship between several hardwood defoliating insects and their parasitoids and predators in an attempt to interface with this weather monitoring system.

How might this information be useable to arborists and municipal foresters? Hopefully, through County Extension Offices or other agencies with Tele-type or other forms of direct-line connections with the computer, a person can receive this information for making control considerations. This system could be applicable against many insects of local importance as well as for major pests such as Gypsy moth, southern pine beetle, etc. on a regional basis.

Most organisms have distinctive odors or emit chemical materials for attracting a mate or as defense mechanisms. The chemical certain female insects emit (called a pheromone) has either been extracted and/or duplicated for a number of insects. Perhaps the best known example of a shade tree pest is the Gypsy moth and the synthesis of its pheromone now known as disparlure. The potential of these attractants appears significant. Not only can they be used to bait traps to time insect activity, detect new infestations, delimit the extent of old ones, but more recently to confuse male moths (an approach now being utilized against Gypsy moth). Obviously this is practicable only over large areas and as yet has not been completely successful. However, the use of pheromones may have immediate potential for predicting the timing of chemical control applications and elimination of males by luring them to traps.

Research in Ohio by Dr. Nielsen (1974) and his associates has shown that certain clearwing moths produce a pheromone. They have isolated and demonstrated the attractancy of this compound to the lilac borer, *Podesia syringae syringae*, and the oak borer, *Paranthrinia simulans*. Work is continuing on the use of this compound to more accurately time insecticide sprays and to mass trap adult males to prevent fertilization of females. Such traps are easily handled, and examined yet provide the exact timing of controls which we currently lack for certain insects.

Host plant resistance would appear to be the ultimate in insect control. Taken for granted are the developments that have been made in shade tree selection for color, shape, growth rate and hardiness. However, little has been done to develop a selection program for shade tree insect resistance on the same plateau that has been utilized on agronomic crops. Campbell (1972) recognized in this approach the capacity to observe and selectively propagate those plants growing amidst greater damage than they themselves were undergoing. This could be done by observation and selection rather than establishing the exact mechanism of resistance. Several obvious insect-host relationships come to mind; varietal susceptibility by various spruces to eastern spruce gall aphid, *Adelges abietis*, varietal differences of Scotch pine to European pine sawfly, *Neodiprion sertifer*, attack and plant bug, *Orthotylus chlorionis*, and leafhopper, *Macropsis fumipennis*, damage to different selections of honeylocust.

One must not forget that the pest-host relationship is not static; but ever changing. The recent collapse of several resistant European clones to the Dutch elm disease fungus in England (Heybroek and Holmes 1972) attests to the fact that a constant biological tug-of-war is occurring.

In some respects in our utilization of plant material we have violated this rule of natural selection. It is an established fact that under normal conditions insects occupy selective roles in their relationship with plants (i.e. destroying weakened or overmature specimens, thinning dense plantings, etc.). Consider then what we do in the use of plant materials in the urban landscape where we may utilize material in a way which will lead to its demise. For example, paper birch, *Betula papyrifera*, grows exceedingly well under forested conditions. Place the same species in an urban site, weaken it by birch leafminer attack, lack of moisture and fertilization, and severe damage by the bronze birch borer, *Agrilus anxius*, occurs. It is therefore as senseless to introduce plant material of questionable adaptability into the urban environment as a noxious insect or disease. This concept is receiving considerable attention by a number of entomologists and pathologists.

So far I have discussed what I consider to be the major directions of non-chemical control for shade tree insects. Many of these management techniques are still in the developmental phase and show promise but the fact of the matter is chemical and biological insecticides will continue to constitute a major management tool. However, the development of chemical control materials and methods is not a glamorous one, hence, interest in such research by university, state and federal sources has waned.

Perhaps most critical is the lack of support by the chemical industry itself to encourage efficacy programs for non-food minor crops. The current trend among shade tree and ornamental researchers is to zero in on 2 or 3 major tree pests rather than attempting to research a diverse number of pests. Undoubtedly this will lead to more definitive data in specific areas yet it diminishes the probability of solving a variety of pest problems on different tree varieties.

Hopefully there will be attempts to maximize effectiveness of chemicals and insure their compatability with parasitoids and predators. This requires continual intensive research and monitoring. To date it has been difficult enough to merely develop chemical controls and get them registered let alone determine their compatability with a biological control system. Thus, to develop and implement an integrated control program requires cooperative efforts between research and municipal shade tree pest control personnel, as was done in the Berkeley California program.

Since the outlook for developing and registering a variety of new pesticides for shade tree insect control is not optimistic, we must maximize the uses of those available. Under FEPCA the classification of pesticides (restricted and general use) can and will change. Therefore, we should strive to preserve their availability by reducing misuse or questionable use patterns since they will likely influence the future categorization of a chemical. The intent of FEPCA is to encourage proper pesticide usage meaning that unwarranted applications such as routine protective sprays in the absence of a problem will be suspect.

I believe that you as arborists or plant protective specialists can ensure that FEPCA will be promulgated without penalizing current pesticides and their uses. For example, it is far better for you to sell your services as a professional by appraising the problem and suggesting appropriate remedial action. This is far more supportive of FEPCA and the property owner than offering a program of "treating your trees 3 times a year for $150."

In other instances new application methods can utilize a chemical in a manner compatible with beneficial species. Aircraft application has great potential for treating large trees or big acreages of trees efficiently. Chemical or biological insecticides can be applied accurately, quickly, at the precise time in urban or park areas. This may be employed to favor certain beneficial species.

Capitalizing on helicopter application of insecticides we were able to suppress a heavy population of fall cankerworm, *Alsophila pometaria*, and spring cankerworm, *Paleacrita vernata*, in a Michigan park system, by allowing a major parasite, *Phobocampe clisiocampe*, to assert itself (Wallner 1971).

Since that time, we have been investigating the use of the Beeco-Mist nozzle system for accurately delivering insecticide sprays of known droplet diameter. The red-humped oakworm, *Symmerista cannicosta*, and variable oak leaf caterpillar, *Heterocampa manteo*, were effectively controlled by both dilute as well as ultra low volume chemical and biological sprays delivered by this spraying system.

Undoubtedly there are numerous researchers with similar unpublished efficacy data. I have neither the time nor space to cite them. However, I would suggest that a clearinghouse for such data, whether on a regional or national basis, is essential to facilitate needed registrations.

Shade trees, like ornamentals, are considered a minor crop despite their major economic value. As such they suffer from the affliction of having a questionable, non-food crop, economic status not only by the chemical industry but also state and federal agencies. This dictates low priority to develop new data or reassess old insecticide uses which are compatible with integrated control programs.

Under FEPCA many previously recommended insecticide controls are now illegal to use because of their nonregistered status or the lack of supportive data. This will critically reduce those insecticides available for shade tree insects and could significantly reduce attempts to pursue specific uses for pest management programs. Furthermore, it costs just as much if not more to derive insect control and environmental impact data for shade trees because of the large size of trees and plots than for agronomic crops. This means that during this period of budgetary constraints shade trees and ornamentals will very likely receive low priority in the allocation of research resources in most states and provinces.

FEPCA establishes many new regulations which will directly affect most people in shade tree pest control. This topic was covered in detail last year by Johns (1973). There have been no significant changes in these regulations but several timetables have already been met, exceeded or appear to be facing extension. The timetable of Enactment of FEPCA October 21, 1972, and publication of disposal and storage regulations May 23, 1973 have been met. The standards for applicator certification due to be published on October 21, 1973 has yet to be done. Future deadlines are; promulgation of regulations governing classification and registration of all pesticides, October 21, 1974; state compliance on certification of applicators, October 21, 1975; and certification of applicators and registration/reclassification of all pesticides, October 21, 1976.

Certain developments eschewed in FEPCA will dictate new educational directions. Under the law, two categories of pesticides (restricted and non-restricted) and two categories of applicators (commercial and private) are established. The specific standards of competency for each of the 10 categories of commercial restricted use applicators will differ. Following is EPA's summation for ornamental and turf pests which will apply to most people engaged in shade tree pest control:

> Applicators shall demonstrate practical knowledge of pesticide problems associated with the production and maintenance of ornamental trees, shrubs, plantings and turf, including cognizance of potential phytotoxicity due to a wide variety of plant material, drift and persistence beyond the intended period of pest control. Because of the frequent proximity of human habitations to application activities, applicators in this category must demonstrate practical knowledge of hazards to humans, pets and other domestic animals.

Shade tree pest control has many unique pest problems and makes the establishment of standards and development of educational materials difficult. By October 21, 1976 FEPCA will be enacted and all pesticide applicators will be tested, and licensed within their respective states. In most states Cooperative Extension Service serves as the educational organ while the State Department of Agriculture is responsible for testing and licensing.

Michigan State University was chosen by EPA to develop training materials and modules for the ornamental and turf pest control category. These materials are intended to be appliable for use in every state for utilization by the educational agency in applicator education. We at Michigan State University have not yet begun to develop these materials but are in the final stages of negotiating a grant which will enable us to do so. We would like as much input as possible from the shade tree industry and would certainly be willing to consider any written comments or recommendations that the ISTC has to offer. The National Arborists Association has already furnished us with written material and we would hope that other interested organizations would do the same.

Suggestions on the type of educational materials i.e. preference for series of general educational meetings, individual slide-tape presentations, etc. would be most helpful in determining the best procedure for your education. The content of the material will depend largely on the standards established by EPA for certification. Since these have not yet been released it is impossible to state categorically what and when the educational material will be completed. In order to satisfy the present EPA timetable this educational material must be developed for use by October 21, 1975.

Another critical fact relates directly to states passing enabling legislation. It will be difficult for each state to pass legislation enabling it to implement these certification standards on schedule with the delays that have already occurred.

You, as practicing arborists and plantsmen, should maintain a keen interest in your profession. I hope that the membership of I.S.T.C. will consider carefully the following suggestions:

1. Work through your various chapters in creating an awareness for supportive research and practical information on shade tree pest problems. Each region, under the auspice of the I.S.T.C., should emphasize the critical need for shade tree and ornamentals pest managerment research to Directors of State Experiment Stations, Federal Laboratories and Chemical Industry Representatives.
2. Request that EPA, in replacing state labels with federal preemptory labels, consider establishing registered uses on the basis of efficacy on groups of plants rather than species or varieties. For example, if control information is demonstrable for an insect on Scotch pine then it should hold for other pines and conifers which this insect attacks.
3. Resolve that both USDA and EPA commit monetary resources to each region for developing efficacy, safety and phytotoxicity information for shade trees and ornamentals. (Resources have already been granted by USDA-CSRS on regional basis to ascertain residues of pesticides on minor food crops.)
4. Resolve that USDA, through its newly established position of National Registration Coordinator (being filled by Mr. Kenneth Walker of the Agricultural Research Service) give sufficient emphasis to facilitate the registration of critical minor pesticide use on non-food crops. Also included would be any research coordinated and supported by USDA at Federal, State and University laboratories.
5. Recommend to the Committee of Nine (which is the policy-making body for all state experiment stations) that they expand the role of their Interregional Project Number 4(IR4) to include non-food crops. IR4 would thus coordinate the data and research needed for registering minor pesticide use on these crops even though a tolerance is not required as it is in food products.

I believe that by following these suggestions certain pitfalls can be avoided. Furthermore, by adopting these resolutions, ISTC can act in a positive fashion to significantly influence future developments and directions critical to shade tree entomology.

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ABSTRACTS

Hernandez, T. J., W. H. Hudson, and T. T. Rushing. 1975. **A progress report on DPX 1108 brush control agent.** Northeastern Weed Science Society Proceedings 29: 325.

"Krenite" (DPX 1108) (ammonium ethyl carbamoylphosphonate) a plant growth regulant has been extensively tested by DuPont Field Test Personnel in the northeastern United States during the last two years. It is promising for control of several brush species of economic importance on rights-of-ways on railroads, utilities, pipelines, drainage systems and roadsides. Rates of 6 to 10 pounds active/acre applied via standard application techniques, one to two months before leaf senescence (usually August or September) has been effective on such troublesome species as pines (Pinus spp.), oaks (Quercus spp.), black locust (Robina spp.), hawthorn (Crataegus spp.), sumac (Rhus spp.), blackberry (Rubus) and maple (Acer).

Medicky, E. J. 1975. **Aerial application of herbicide pellets for brush control on power line rights-of-way.** Northeastern Weed Science Society Proceedings. 29: 331-335.

The on-target application of Tordon 10 K (4-amino-3,5,6-trichloropicolinic acid) pellets from aircraft poses increasing difficulties as flying height and speed increase. In 1973, Ontario Hydro evaluated three pellet dispersal systems in order to arrive at a system which could deliver 35 to 50 lbs product (3.5 to 5.0 lbs ai) on target from flying heights ranging from 100 to 300 feet. The Grumman Venturi and the Field Aviation Pellet Dispersal Systems indicated that good dispersal was provided with respect to swath width distribution, and delivery rate. Difficulties were encountered with respect to swath width and delivery rate in the Simplex Seeder System. Further development work of the three systems is planned in 1974.