

FIELD OBSERVATIONS OF TREE INJECTION¹

by James W. Orr, Stewart Leonard and Joseph Lentz

Abstract. This paper examines tree injection from the view point of the contracting arborist. Contract arborists are responsible for applying the art and science of tree injection, as developed by the utility foresters, city arborists and chemical manufacturers to its commercial phase. In making a commercial application of plant growth regulators to trees, specifically those trimmed around electrical wires, the contract arborist has encountered a multitude of unexpected situations. These operational problems continually hinder the practice, development and refinement of this new science or management tool. Problems of tree physiology and program implementation were not solved until the desired material could be placed in the tree accurately and consistently. Today many equipment variations exist, each filling a perceived need in the search for reliable trunk injection equipment.

Résumé. Cet article présente une analyse des injections dans les arbres du point de vue de l'arboriculteur engagé à contrat. Les arboriculteurs sont responsables d'appliquer l'art et la science de l'injection, tel que développés par les forestiers des compagnies de services publics, les arboriculteurs municipaux et les fabricants de produits chimiques. En réalisant une application commerciale de régulateurs de croissance sur les arbres, principalement ceux élagués sous les fils électriques, l'arboriculteur à contrat a rencontré une multitude de situations inattendues. Ces problèmes opérationnels entravent continuellement la pratique, le développement et le perfectionnement de cette nouvelle science ou outil de gestion. Les problèmes reliés à la physiologie de l'arbre et à l'application d'un programme ne furent pas résolus avant que le matériel désiré ait pu être placé dans l'arbre avec précision et consistance. Aujourd'hui, différents types d'équipements existent, chacun remplissant un besoin identifié dans la recherche d'un équipement permettant une injection efficace dans le tronc.

Throughout the last decade, the number of trees treated with growth regulators has increased at a dramatic rate, doubling annually. Three out of four major electric utilities nationwide have tried Tree Growth Regulators (TGRs) on trees growing under electric lines. The increase in treated trees and number of meetings or symposiums on tree growth regulators clearly shows the growing interest of electrical utilities in the chemical regulation of tree growth. The potential benefits of TGR use to the utility, and the general public, demand

attention to this developing management tool.

The contracting arborist (contractor) is the link between theory and reality. The contractor is responsible for the physical application of TGRs to trees, as developed by the chemical manufacturers, scientists, and utility foresters. Although specializing in utility line clearance, the contractor may offer many related services. Tree injection is being adopted as a logical extension of the service line, of which helps the contractor maintain an interest in the development of trunk injection.

The use of TGRs by electric utilities will extend the trimming period (cycle), reducing the annual cost of line clearance considerably. Flexibility is added to the trimming schedule, minimizing the emergency situations to which contracting crews must respond. Reduced tree growth also will affect future trimming schedules. With less biomass removed from trees with each trimming, the productivity of contract crews should increase, resulting in fewer crews required for a given area. The utility should continue to realize a decreased cost with the passing of each completed cycle. Budget reductions may be feasible in the future if fewer tree crews are required to support a given area.

Contractors will benefit directly from the use of TGRs. TGR application represents a growing new service that can be marketed to customers. Clear and simple, the motivation is profit, an incentive which must be emphasized, when questions of poor results, liability, and investment cost cloud the participants thinking.

Contractors should experience many side benefits as well. Reduced tree growth places crews in "less-hazardous" situations, possibly reducing insurance liability and workmen's compensation rates. This cost of doing business may amount to as much as 50% of the total cost of labor. Safety (minimum clearance) requirements will be more easily maintained, possibly reducing

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employee turnover, thus lowering the additional cost of hiring and training the existing labor force. When trunk injection of TGRs becomes standard procedure for a utility system, less severe trimming may be required, while maintaining service reliability. This alone will reduce complaints from property owners dealt with by the contract crews.

The general public ultimately will benefit from TGRs through healthier trees. Injection of TGRs is less harmful to the tree than repeated periodic trimming. Trees are healthier in appearance, have a darker color, with increased fruit and flowering. Indications show that injected trees can better withstand the effects of drought, insect infestations, and disease. At the minimum, homeowners would be approached less often for permission, and traffic patterns on neighborhood streets disrupted less frequently.

Even with all the apparent benefits of TGRs, the development of products, application equipment and techniques progress at a sluggish pace. Many of the initial trials with trunk injection gave questionable results, often due to equipment inadequacies of the time. TGRs could not be placed in the tree accurately and consistently. Today, many improved equipment variations exist, each filling a perceived need in the search for suitable and reliable injection equipment. However, the preferred choice of equipment should be left to the participant responsible for the injection.

With materials more accurately placed in the trees, great advancements were made in areas dealing with the application. Specifically, changes in probe spacing increased uniformity of results. Modifications in probe designs have increased the rate of uptake of growth regulator formulation. Dosage and volume relationships established rate guidelines for further experimentation on different tree species.

The timing of the application appeared to be a controlling factor in the appearance of the response. And yet, inconsistencies in results puzzles those involved, and still puzzle us today. Many developments have been made towards refining the application of TGRs in recent years, but the process is not over. In fact, it is just beginning. Participants must continue to question the responses seen and search for answers to many existing questions on the application of TGRs.

The "new breed" of growth inhibitors currently under examination are superior to those previously used. These materials are essentially non-phytotoxic, and offer extended control with greater levels of activity. Also, depending on the climatic conditions, they may be successfully and economically applied on a year-round basis, another benefit to the user. However, much information is still needed on the new materials.

Presently, Clipper® (ICI) is the only anti-Gibberellin approved by the Environmental Protection Agency. Gibberellic acid is an enzyme required for terminal leader growth. The original label has been expanded to cover eighteen major species, although any utility may encounter 30 or more different species on a property. More information must be collected to encompass a greater number of tree species. In California, for example, more than 100 species of eucalyptus exist, each potentially exhibiting a different response of a given dosage. Any treatment modification possibilities could be confusing for the application crew and non-productive (and expensive) to the customer.

Because TGR materials can remain potentially active for 3 years or more, the long term effects of the compounds on trees cannot accurately be evaluated in a short period. Long term tracking may prove to be necessary. Tree injection cannot be linked with improved tree health without statistics to substantiate our claims. Record keeping and data collection before *and* after injection is vital to a successful program.

The solubility of a TGR relates directly to the movement within a tree. The anti-Gibberellin compounds under examination are virtually insoluble in water. Solubility rates vary from fifteen (15) ppm Prunit® (Chevron) to one-hundred and thirty-five (135) ppm for Cutless® (Elanco). How significantly this variation in solubility relates to differences in activity or duration of effectiveness is a question that must be addressed. When comparing results of two or more compounds, we must be aware that we are comparing apples to oranges.

To further compound the problem of product solubility and resulting movement within a tree, differences in tree physiology by species mandate varied dosage requirements. For example: sycamore(s) require approximately five times the

amount of active ingredient as Norway maples. Independent of this, there are geographical variations by species. Climatic conditions are an important factor in predicting rate response, evidenced by growth differences among properties treated on Philadelphia Electric and Potomac Edison (Hagerstown, MD) properties, a difference of only 150 miles. Many utilities have larger service territories. Geographic and climatic factors must be considered before application prescriptions can be attempted.

Variations in response among identical species in the same general location have been observed. Environmental stress due to minute differences in available moisture, soil type, or nutrient composition all may play a part. Whether natural or "man-made", environmental stress affects the systemic movement of materials within trees, as evidenced by variations in annual growth ring measurement.

While environmental stress plays a delicate role, however small, nothing controls the systemic movement of materials within the tree more than the seasonal changes in temperature, daylight, and available water. The insolubility of the new compounds shows itself in a delayed response to the time of treatment. Therefore, the timing of the treatment in relation to trimming can ultimately determine the amount of regrowth that occurs.

Generally, fall treatments allow sufficient time for movement of a material to be more uniformly distributed within the tree crown when growth begins the following spring. Initial Potomac Edison data suggest that January injections lead to an overall increase in growth, rather than a reduction. This response is later reversed during the following years, however, in commercial practice, the application of TGR is not geared to the seasons, but rather to the trimming operations which occur on a year-round basis.

Injection by the trimming crew minimizes additional labor and equipment charges incurred from returning to the tree at a later date. Due to the response delay, early summer treatments may not regulate the critical first year regrowth, which may amount to over 50% of the cycles total regrowth. This situation protects the homeowner against the "just-trimmed" appearance, but may worry the line clearance supervisor and jeopardize the service reliability the utility has strived to gain.

tively reduce the majority of expelled material by simultaneously venting the injection system and use of a specialized injection crew, consisting of 1 or 2 persons and a service vehicle. Specialized crews insure a higher quality of application and introduction to the property owner. Initially, program implementation with this crew arrangement has been more successful due to many reasons, one being the freedom from trimming/timing constraints. Refusal rate has shown to be significantly lower...with a specialized crew.

Injection prior to trimming provides faster uptake and more uniform control due to the added canopy which improves transpiration rate and distribution. Treatment time can be correlated to response time to insure maximum growth retardation. Injection by a specialized crew prior to trimming could also secure the necessary permission to trim from the homeowner which would result in a more productive trimming operation.

Early growing season injection following winter trimmings would not be hampered by slow uptake associated with dormant season treatments. Spring injections might also avoid the potential of a negative response by the tree to the drilling wound. The drilling techniques used may prove to be related directly with the wounding response of the trees. The new materials may not only slow the annual growth rate but also may affect the rate of wound closure. Species and seasonal variation all may be interconnected.

Drilling aspects must be considered on both the horizontal and lateral planes. Presently, injection sites are drilled generally horizontal to the ground at a 30-45 degree angle to the plane of the tree trunk, depending on the bark thickness. Wood of greater densities such as Oak, Maple, etc. may be drilled at a relatively lesser angle, while softer, less dense woods require a greater angle to reduce the risk of "bark blowout," or expulsion of the material through the bark. The question is: How do differences in hole angles affect the uptake, distribution and duration of effect?

The horizontal plane should also receive attention. Many TGR participants are currently drilling holes at a five degree (5°) downward angle, allowing the injection sites to act as a reservoir which collects any material returned from the tree. Observations show that the applicator can effec-

The delay problems or response irregularities of tree crew injection can be minimized through the the tree of residual pressure. A potential issue for consideration is that, a five degree (5°) downward angle from horizontal not only collects active ingredients, but also rainwater, bacteria, fungi, and mineral deposits. These deposits may slow the wound closure and worsen the condition of the injection site. Drilling at a five degree (5°) upward angle may allow the injection site to serve as a drain for collecting bacteria and other potentially harmful materials and could better insure proper wound closure. How much material (active ingredient) would be lost is difficult to quantify. Most likely any material loss would result in reduced duration of control, rather than effectiveness of control.

Hole dimensions have changed in diameter since trunk injections were first conducted. Probe diameter has decreased from 1/2 inch to 1/8 inch with 3/16 - 7/32 inch diameter the most common probe size. Larger diameter drill sizes increase the rate of uptake and improve the uniformity of control by exposing more xylem cells for systemic movement. Smaller holes minimize injury to the tree at the drill site, but at what reduction in uptake and distribution? Hole depth may also prove to be important. Current label recommendations state proper hole depth is between 2-2½ inches. Drilling too deeply may lengthen duration of effect, but reduce the overall control. Shallow drilling sites would force backtracking to reconfirm established spacing guidelines.

Regardless of the diameter, drill bit type also affects the rate of uptake. Twist drills were commonly used in early trials because of their availability. Twist drills have shown to produce a rougher cut of the xylem cells, possibly impeding uptake and distribution. Brad point drills make a cleaner cut of the xylem cells, improving rate of uptake and uniformity. Regardless of the type, a sharp cutting edge on the drill bit is essential for injection. Likewise, drill speed has not fully been investigated. High speed drills may cause excessive friction to the conductive tissue of the plant, impeding uptake. This may relate directly to poor wounding response by the tree.

As we have discussed, the health of any individual tree is a result of the growing conditions

up to that point in time. For example, an increase in rainfall, following a drought, dramatically improves the systemic movement of a tree, and its ability to respond to wounding. Natural stress components (rainfall, insects, etc.) can be compounded by the man-made stresses of construction, overcrowding, or repeated trimming. The rate of systemic flow of materials within the tree is directly connected to the environmental stresses on the tree, and can become apparent in the growth response. Often these responses manifest themselves as "over dosages" or "mainlining" of TGR. Prior determination of stress is difficult to measure because of the variety of factors involved. Tree injuries affecting efficacy may be hidden beneath the bark, from view of the applicator. Poor wounding response of the injection site may not become apparent for years following the application. We realize the time frame of tree growth does not correlate to people. Trees may take years to show or correct an injury. First we must address all aspects of injection wounding, separating any chemical connections. Then, we may address the issue of repeated injections.

In summary, many facets of tree injection have been discussed. From the new materials to wounding response of the tree. Many advancements have been made in recent years, but obviously many questions are still to be addressed. What about climate variations? Micro site stress variation? How do temperature variations affect the solubility and availability of new materials? Can we predict tree health? Or correct our application procedures to eliminate, or reduce the inconsistent responses by the trees? Yes, there are many questions still to be answered.

Tree Growth Regulators promise many benefits to all those involved: the utility, the contractor, and the general public. To advance the application of TGRs to commercial status, participants must attempt to develop this new technology by striving to understand the contributing factors which affect results. As an industry, communication of our efforts and results, either success or failure to others involved is essential for advancement. We must promote our efforts with TGRs and educate the general public to insure acceptance of our programs. Only through communication and collaboration of efforts by the participants will the

science of TGR trunk injections be refined, and thus become an economical and effective standard practice for the utility industry.

*Manager and Supervisors, respectively
Asplundh Tree Expert Co.
Willow Grove, Pennsylvania 19090*

UTILITY AND MUNICIPAL COMMUNICATIONS RELATING TO THE URBAN FOREST¹

by John D. Morell

Abstract. Municipal and utility companies working together can protect and enhance urban trees. Augering, instead of trenching, through the root zone area of trees using the Parkway Tree Augering Specification developed by the Municipal Foresters in Northeast Illinois, and using various trimming techniques other than "topping", for clearance of electrical transmission lines, should be used to protect the urban tree population.

Communications is defined in Webster's *New World Dictionary* as the act of transmitting, the giving or exchanging of information, signals, or messages by talk, gestures, writing, etc. Clear communication between municipalities and utility companies is the key to understanding the goals and objectives of each organization. Once the goals and objectives of each are clearly understood, it's easier to work towards accomplishing these goals and objectives.

In Park Ridge, I have the responsibility for approving all utility permits that involve the City's rights-of-way, including permits requested by the

electric, telephone, and gas companies. Prior to my being assigned this responsibility, I asked that I have the opportunity to review any construction plans, where parkway trees exist, prior to the issuance of a permit or the start of work if accomplished by the City or its contractor. It's important for each of us to be a part of the review process for construction permits so that we understand and have full knowledge of what's going to occur when construction begins on our urban rights-of-way. You should also attend preconstruction meetings.

In Park Ridge, applications for work in the rights-of-way are received in written form, and it clearly states on the application, along with attached map, what work is to be accomplished. Trenching damage to a tree's root system causes slowing of the growth rate, dieback and decline of the tree's crown and/or root system, deadwood formation, windthrow, invasion of wood decaying fungi or insects or total tree mortality. Augering, or boring

1. Presented at the annual conference of the International Society of Arboriculture in Vancouver, B.C. in August 1988.