TRACING TURFGRASS HERBICIDE DEVELOPMENT

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What a privilege it is to share with you some thoughts on turfgrass herbicide development at another great Michigan State Turf Conference. My sincere thanks and warmest regards to all of you, who so graciously invited me to participate.

Way back when I was a sixth grader, only the "smart kid" in our class raised his hand and had the answer, when our teacher asked, "What is a weed?" He said "A weed is a plant out of place." Since then, you and I have heard many definitions of the word "weed," but none, I believe you'll agree, that improves upon that original one.

Weeds competed with desirable economic crop and recreational and aesthetic plants as far back as 10,000 years ago--as soon as man began organized agriculture (1). For about the first 9,900 years, weed control was by sheer human exertion and mechanical means--hand weed-pulling, followed by the stick, the hoe, crop rotation, horse drawn machinery and the like. Under these conditions, the efforts to get rid of the weeds often did exactly the opposite, creating soil and environmental conditions where weeds flourished as they hadn't ever before. In fact, the majority of our common weeds today are said to have been very rare plants, before man became an agriculturist and provided the ecological situation under which the weeds, too, thrived.

Chemical weed controls have been around for at least a century, the first such chemicals being total weed controls--removing all growing plants from such places as railroad tracks, timber yards, unmetalled roads, etc. These chemicals included such unsophisticated materials as rock salt, crushed arsenical ores, creosote, oil wastes, sulfuric acid and some of the copper salts. BUT--what were really needed, above all else, were selectivecontrol chemicals--to eradicate the weed plants, and promote (or at least not harm) the desirable crop and recreational plants (1).

In the early 1900's, "some" selectivity was achieved with soluble copper salts and sulfuric acid, based upon the physical factors of the plants. The larger, rougher surfaces of the broadleaf weed leaves were more effectively wetted by the sprays, as compared with the narrow smooth leaves of cereals and turfgrasses, in which there was greater and faster run-off and less absorption of the toxicants.

The first important selective weed control came in 1933, in France, when the contact herbicide, 2,4-dinitro-o-cresol, otherwise known as "DNOC", was introduced there. It killed most (not all) annual weeds, but not perennials, like creeping thistle, bermudagrasses, etc., because although their top-growth was dessicated, the material was not translocated, so that the roots and rhyzomes survived and sent up more living shoots later. In any event, this chemical was the forerunner of many other selective herbicides, from the late 30's on, and continuing today.

1945 literature (2) lists ammonium sulfate, ammonium sulfamate, iron sulfate, oils, sodium arsenite, sodium chlorate, sodium chloride (common table salt), sulfuric acid, ammonium thiocyanate, lead arsenate and zinc sulfate as good turf herbicides, potentially--AND, in this group is mentioned, for one of the very first times, "2,4-D," which, as you know, is the one surviving longest from the group, and certainly the one which you, over the years, have used most extensively for broadleaf weed control in turf.

It is said (3) that the science of weed control has advanced more since 1942 (the first year of use of 2,4-D) than in the previous million years! And yet,

authorities feel chemical weed control is still in its infancy, and that the eventual "ultimate" herbicide will kill all plants except the single desired crop!

In our limited time here, let's just touch upon some of the "highlights" of the more important turfgrass herbicide developments that lead us to where we are now.

1. As mentioned, 2,4-D was first among modern post-emergence broadleaf herbicides, being introduced in 1942.
2. Selective post-emergence control of weedgrasses (as contrasted with broadleaf weeds) began in the later 40's and early 50's, when phenyl mercuric acetate (as PMAS, PHENMAD, etc.), orginally used only as a mercurial fungicide, was found to be a good selective crabgrass killer, even in bentgrass greens, although its phytotoxicity level was such as to require very special care in handling.
3. In 1945, a man named Templeton, in England, first established the pre-emergence principle, of soil treatment for selective annual weedgrass control. Based on this early development, within several years, in the early 50's, other pre-emergents made their appearance, among them Dow's Zytron, designed specifically for the control of crabgrass in lawn and golf course turf. Competition was almost vicious--Zytron's several weaknesses allowed the entry of a great number of other pre-emergents, including Diamond's Dacthal, Elanco's Dipan and Treflan, and others. One or more of these was orginally intended as drug "intermediates"--and industrial research brought out that they had pre-emergence crabgrass control properties.
4. Overlapping this period, and continuing for some years, were the arsenates and arsonates of lead, calcium and sodium. Lead arsenate, often used routinely for soil insect control, had been found useful in pre-emergence weedgrass control. It was superceded in the late 50's and early 60's by calcium arsenate, through such work at Purdue, and by industrial research by Chipman, whose "Chip-Cal," in granular form, gained a prominent place in turf weedgrass control. Unpredictability of some arsenates, under varying climatic and soil conditions, caused some problems in the late 60's and early 70's, but these became academic in more recent years when our EPA "friends" wiped the arsenicals from the market for turf use.
5. The search was on for broader spectrum and safer (for bentgrass use) pre-emergent controls, and in the mid-60's Mallinckrodt and Stauffer registered their PRE-SAN and BETASAN brands of the chemical Bensulide, which, even today, ranks "Number One" in (a) long residual control, (b) good effectiveness, (c) almost "zero" phytoxicity, being still the only pre-emergent chemical actually labeled as safe on the bentgrasses, and (d) offering control of "all three" major weedgrasses, crabgrasses, goosegrass and Poa annua.
6. Subsequently, Elanco launched its pre-emergence Benefin, under the "BALAN" trade-mark. Although it is not yet registered for use on some of the bentgrasses, particularly putting greens of bentgrass, and has some limitations in Poa control, BALAN's low per-acre cost and other advantages have gained it wide acceptance for use on large areas, such as industrial parks, golf course fairways, athletic fields and similar areas.
7. The "Growth Regulator" must be considered in the realm of "herbicides." One of the first such chemicals was Gibberellic Acid, researched for quite a time in the early 60's, with strong basic work done at the

University of Rhode Island. This chemical promoted turfgrass phenomenally. During a Rhode Island Field Day, some of us saw a Gibberellic Acid plot of bluegrass at least a foot or more tall, and of very light yellowish green color, compared with the adjoining check plot of 1-inch tall deep green bluegrass. The material never really "got off the ground" for turfgrass use, likely because no one could visualize actually wanting 1-foot tall very yellow bluegrass.

8. A more important growth regulator was Maleic Hydrazide, which was discovered to inhibit the growth of turfgrasses and other plants. It was visualized that a single application of Maleic Hydrazide could stunt the growth of all turf on an entire lawn or golf course. However, all grasses do not respond uniformly to Maleic Hydrazide treatment, and it is seen that uniformity (rather than short height of cut) is the thing of prime importance. A Maleic Hydrazide-treated fairway would be short overall, of course, but because the growth of some grasses wouldn't be stunted like that of others, the result was found to be an overall "scraggly" appearance, which meant that as much mowing was needed as before, to achieve the desired uniformity of height of cut of the grass.
9. A relatively recent important broad-spectrum post-emergence control for broadleaf weeds is the combination of 2,4-D, MCPP and Dicamba, marketed under several formulations, as "TREX-SAN" by Mallinckrodt and as "TRIMEC" by Gordon. Whereas 2,4-D itself, controls only "some" major broadleaf weeds, MCPP only a few, and Dicamba only a few others, the synergistic combination will eradicate almost 100% of unwanted broadleaf infestation, from the tiniest of clovers up to the huge-leafed Kudzus in the South. While one or more of the components may be suspected of being some sort of environmental hazard by the EPA, nothing thus far has been documented along this line, so that TREX-SAN and TRIMEC are, as of now, "the best there are" in complete broadleaf weed control.
10. Not to be left out of the "pre-emergence" is the chemical Siduron, offered 10 or more years ago by DuPont, and still in favor for a number of uses, under the label "TUPERSAN". With its pre-emergence crabgrass control, it offered the unique feature of allowing overseeding of desirable grasses right along with the application of the chemical. Differences in the make-up of some bluegrasses, and the sensitivity of some of the bentgrasses to TUPERSAN, have thus far limited its expansion of wide use.
11. No current weedgrass discussion would be complete without mention of Pronamide, marketed as "KERB" by Rohm & Haas. Up here it is of limited use and significance, but in the deep South it has become a "must" as a control for cool-season grasses, especially Poa annua, in growing warm-season bermudagrasses and zoysias. It is the only chemical thus far promoted with this unique property. However--even now all of its selectivities aren't known, so that special care is advised in its use.
12. Not to be overlooked, in the herbicides-for-turfgrass story, is the unusual combination of Maleic Hydrazide and the chemical Chlorfluorenol, the latter from Germany, designed specifically for eliminating Poa annua from fine turfgrasses by the simple expedient of preventing the Poa plants from producing seeds. Some 7 or 8 years ago, Mallinckrodt began marketing the combination as "PO-SAN." Sprayed over entire golf course fairways, PO-SAN doesn't kill anything--not even existing Poa. It just stunts all fairway grasses, with

special stunting of the Poa, allowing the desirable grasses to grow and develop, and almost completely inhibiting the production of the Poa seeds which would assure a larger crop of Poa next year. It has "zero" effect on the soils, and allows seeding of desirable grasses before, during or immediately after the PO-SAN application. It has taken some time for acceptance of this combination, probably because turf managers are "gun shy" from having been "burned" by trying new things before. However, there is now strong history of continued safe PO-SAN use over a number of years, with almost complete elimination of Poa from the treated areas, and with continually developing growth of the desirable turfgrasses. Thus, the turf manager now has a chemical that eliminates Poa annua without eliminating any existing turfgrass. Its use on putting greens is still in the development stage, as more research is needed to establish its safety on very short height-of-cut putting green bentgrass.

13. A most notable phenomenon in total weed control, in recent years, has been the development by Monsanto of its Glyphosate, marketed as "ROUND-UP". Relatively non-toxic to mammals, its foliar spray application is translocated both upward and downward, throughout all plants, literally killing them all, on a non-selective basis. It uniqueness is greatly enhanced by the fact that new desirable grasses may be seeded into ROUND-UP-treated areas within 24 to 48 hours after the chemical application, with just about full assurance of complete germination and development of the seeding, because the chemical is rapidly degraded in the soil. It appears to be the true "optimum" when the "fresh-start" approach to excellent turf is decided upon.

With all these fantastic developments in herbicides for turf since 1945, doesn't it seem that the future for herbicides holds great things for all of us? Don't you believe it. With all of EPA's interference with research at every level, and with their regulations costing chemical companies so much that no chemical company can hope to develop something new with which to earn a reasonable profit, your "new herbicide" future is bleak, indeed, unless, by accident, a new compound developed for economic crops "just happens" to have application in turf. Unless such an accident happens, you might well have seen the last herbicide ever to be researched and marketed primarily for turfgrass use.

(1) From "PESTICIDES", by Cremlyn. (John Wiley & Sons, England, 1978)

(2) From "WEEDS OF LAWN & GARDEN", by Fogg (U. of Penn. Press, 1945)

(3) From "WEED SCIENCE", by Klingman & Ashton (John Wiley & Sons, England, 1975)