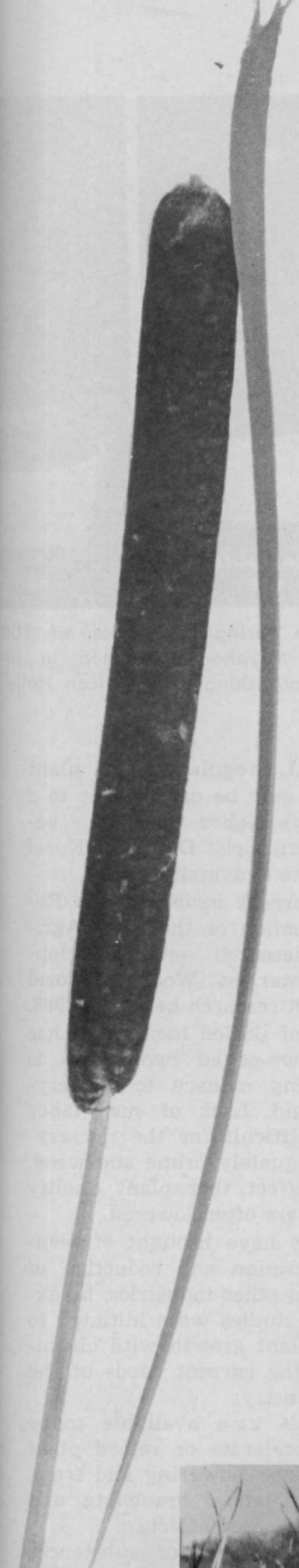

two treatments were used. After the first treatment plants died quickly and the second treatment was applied to dying and dead plants.

In early October, following gathering of data, the entire area was treated with Dalapon at the rate of 8 tbsp/gal. All plants were killed and no regrowth has been noted up to the present time (nearly 6 months later).

*** Thanks to Frank Knesek, golf course superintendent, and Tom Lawrence, manager and club professional, for their cooperation and encouragement.**

Results of herbicide tests on cattails at Oso Beach Municipal Golf Course, Corpus Christi, Texas, in the summer of 1968

Chemical	Dilution	Rep.	Appearance of plants 3 months following treatment
Dalapon* (powder)	8 tbsp/gal	1	All plants dead, brown, and fallen over
		2	" " " " " " "
		3	" " " " " " "
	16 tbsp/gal	1	" " " " " " "
		2	" " " " " " "
		3	" " " " " " "
MSMA** (liquid)	2 oz/gal	1	All plants dead, brown, but not fallen over
		2	" " " " " " " "
		3	All plants dead, brown, and fallen over
	4 oz/gal	1	" " " " " " " ***
		2	" " " " " " " ***
		3	" " " " " " " ***
Amitrole (powder)	6 tbsp/gal	1	Edges of leaf brown, many brown flecks on leaf and stem, plants alive
		2	" " " " " " " "
		3	" " " " " " " "
	12 tbsp/gal	1	" " " " " " " "
		2	" " " " " " " "
		3	" " " " " " " "
Calar** (liquid)	2 oz/gal	1	" " " " " " " "
		2	" " " " " " " "
		3	" " " " " " " "
	4 oz/gal	1	" " " " " " " "
		2	" " " " " " " "
		3	" " " " " " " "
Control (no treatment)		1-6	All plants healthy

* furnished by Eastern Seed Co., Corpus Christi, Texas
** furnished by Vineland Chemical Co., Vineland, New Jersey
*** several healthy plants remain

"Where's the fairway?" Frank Knesek (we think that's who it is) shows the view golfers used to have of the fairway from the 15th tee at Oso Beach.

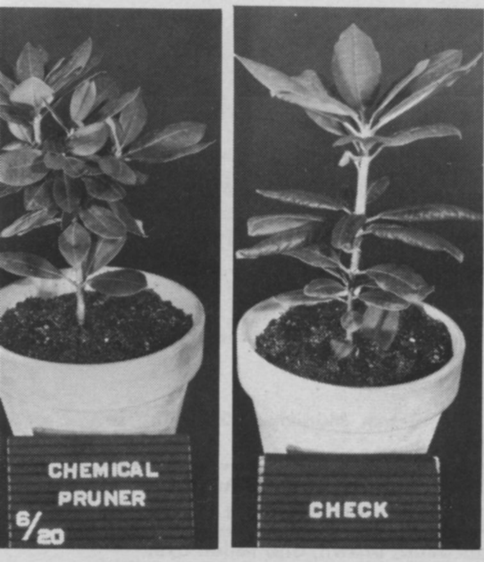

Fig. 1—Increased branching of rhododendron was achieved with a spring treatment of a chemical pruner (8%).

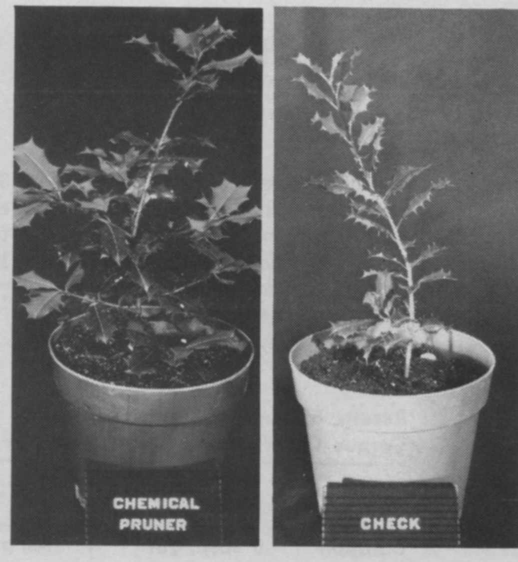

Fig. 2—A spring treatment with a 15% chemical pruner produced increased branching in American Holly.

Fig. 3—A spring application of 100 ppm of Morphactin resulted in increased branching of American Holly.

Ohio Research Report

Chemical Pruning Shows Promise

By DR. P. C. KOZEL, horticulturist, Ohio State University

CHEMICAL regulation of plant growth may be one answer to a nurseryman's labor problem, believes horticulturist Dr. P. C. Kozel of Ohio State University.

In the current issue of Ohio Report, publication of the Ohio Agricultural Research and Development Center at Wooster, Kozel writes about research begun in 1968.

Scarcity of skilled hand labor has forged a two-edged sword that is an increasing menace to nurserymen, he said. Lack of such labor makes it difficult for the nurseryman to adequately prune and weed, with the effect that plant quality and profits are often lowered.

Chemicals have brought efficiencies of operation and reduction of labor cost in other industries, he explained, so studies were initiated to "regulate plant growth with chemicals to fit the current needs of the nursery industry:

"Chemicals are available today that can accelerate or retard plant growth, induce flowering and fruiting, increase lateral branching, and cause other desired effects.

"A great number of substances have been studied and three plant growth regulators have shown outstanding promise for adoption for commercial use."

Of particular significance are the chemicals that can substitute for manual pruning or pinching. These products selectively kill the young shoot apex, resulting in well-branched, high-quality nursery plants with minimum manual labor.

A foliar spray of a chemical pinching agent, Off-Shoot-O, was tried

Beautification Test Plot

Have you considered a "beautification test plot" as a stimulus to bring business your way?

People must have a desire for beauty before they'll plant grass, buy mowers and fertilizer, get their trees and shrubbery sprayed, and so on.

Here's what a Cleveland minister got started.

In a section of town where rutted and barren tree lawns were the rule, the Rev. Sanford Pierce of Holy Gospel Church of God and Mrs. Willie Aetner and her eight children put in some grass to show how it improved the neighborhood.

Extension agent Francis Calderwood was called in to give a grass-planting demonstration. He persuaded the Lakeshore Equipment and Supply Company to donate some grass seed and fertilizer.

Calderwood is thinking now of setting up a lending library of tools, since many of the people at the moment can't afford to buy the tools.

Projects need names and this one is called the Cuyahoga County Beautification Program.

The same kind of a project might work in an area where folks can afford to buy the tools. Whether the project is successful in spreading the desire for beautification isn't yet known. But the "keeping up with the Joneses" psychology has worked wonders in other endeavors.

Fig. 4—A foliar spray of 500 ppm of gibberelic acid (GA_3) increased growth on the viburnum plant at left.

on American holly plants and rhododendron when new growth was about a half-inch long. Young shoot tips were killed within 12 hours with a concentration of 8 to 15 percent of the chemical, Dr. Kozel reported.

A new group of chemicals called "Morphactins" also increased branching, he continued. While these chemicals do not kill the young shoot tip, he explained, they overcome apical dominance and induce lateral branch formation.

"This is an important difference as it is often desirable in the case of shade trees to increase branching without destroying the central leader of the plants."

Kozel reported that American holly plants also were created last year with a foliar spray of 100 ppm of Morphactin at the start of vegetative growth. Chemical application, combined with good cultural practices, yielded high-quality plants by the fall of the same year, he reported.

A few plants were treated with 1000 ppm concentrations of the Morphactins. At this high concentration, terminal vegetative growth was severely retarded. Species variation occurred between Forsythia and Honeysuckle.

In both instances, plants treated in early June were severely retarded in their vegetative growth, little being evident event at the beginning of September.

Forsythia, however, exhibited severe leaf distortion whereas Honeysuckle foliage was normal in appearance.

Viburnum plants were treated with 500 ppm foliar spray of gibberellic acid (GA_3) in the spring when the new growth was about one inch long. Treated plants had an accelerated rate of vegetative growth that was of good quality and considerably greater than untreated control plants.

Fig. 5—Continued research has indicated that timing of the growth regulator application is important. For example, last year 8% Off-Shoot-O was necessary to chemically prune rhododendrons, while this year a 3% concentration was effective. The picture at left shows the stage to treat; the other demonstrates the selective killing of the terminal apex and the subsequent enlargement of auxiliary buds.

Golf Course Maintenance Headed Toward

Total Turfgrass Perfection

GOLF COURSE maintenance is headed toward "total turfgrass perfection," says an industry researcher.

Alexander M. Radko, research coordinator for the United States Golf Association, credits the steady improvement in golf course maintenance to a number of factors. Among them, he cites: new technology and the dissemination of it through local, state and national conferences; sufficient capital; and an increasing number of "inquisitive, college-trained personnel" entering the field.

As industry's wage spiral continues, projections for course maintenance embody fewer—though better paid and informed — ground crews and greater mechanization, Radko predicts.

Emphasis, he says, will be placed on improvements in machinery, irrigation systems, and the installation on new courses of architectural features requiring less hand maintenance.

Greenbrier's Technique

One well-known course that's far along the way toward the maintenance perfection that Radko sees ahead is The Greenbrier, White Sulphur Springs, W. Va.

Superintendent W. D. Haven discussed The Greenbrier's maintenance planning and budgeting at a recent Virginia turfgrass conference.

At present, three Greenbrier employees are assigned to each of the three 18-hole courses. One man cuts six greens, rakes traps, trims, and does odd jobs. Another spends full time mowing tees, while a third does all the cup setting and tee marker placing on each course.

Other facets of the Greenbrier plan include daily mowing and cup setting, with tee markers being moved in relation to the cups each time they are set. The spraying has been changed from a three or four-man operation to a one-man operation on all three courses.

From mid-May to mid-October, the 59 greens are sprayed every seven days, while all 82 tees and the fairways of one course are sprayed every two weeks. To get ahead of the players, spraying is begun at 4 a.m. — with lighted equipment. Two fungicides are used on the greens and tees.

The fairway mowing plan at The Greenbrier calls for mowing four times a week, Haven continued. Installing lights on the equipment and mowing at night has proved advan-

World's Ten Most Hated Weeds

What's the world's worst weed?

Everyone has an opinion. LeRoy Holm, horticulturist at the University of Wisconsin, says the most detested weed is purple nut sedge.

He goes further by listing the 10 most hated weeds, compiled after a study of world weed problems when he was with the United Nations Food and Agriculture Organization.

After purple nut sedge, he lists bermudagrass, barnyard grass, jungle rice, goose grass, johnson grass, guinea grass, water hyacinth, cogon grass and lantana. Eight of these are grasses or sedges and five are perennials. With the exception of guinea grass and cogon grass, these weeds are found on every continent.

"Public enemy weed number one," also called nut grass, nut sedge, coco sedge or coco grass, is common for 2500 miles north and south of the equator and on every continent.

World weed problems do not receive as much attention as more obvious pests, Holm said, such as disease, insects and rats. Yet, he added, weeds are probably taking a greater toll of food that should go to feed hungry people and their livestock.

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tageous, since night mowing does not interfere with the players—a primary consideration for any course, Haven maintains. Also, Greenbrier mowing time has been cut in half.

Since the grass is in better condition for mowing after sundown, as it is cooling off, it is less likely to wilt and is under much less strain. Except on particularly hot days, mowing at The Greenbrier begins at 4 p.m. Brushing is done three times a week.

Plans for improved aerification, drainage, fertilization, and top dressing of greens and tees are in the offing at The Greenbrier, according to Haven, who stressed that since fertilization plans are often subject to change, they are projected on a year-to-year basis.

This coming season, for example, the plans call for the use of nonsoluble materials which, requiring less frequent application, will consume less labor. Also, Haven reported, the Virginia Polytechnic Institute's heavy-winter-light-summer recommendation is to be implemented nearly 100% at The Greenbrier during the coming season.

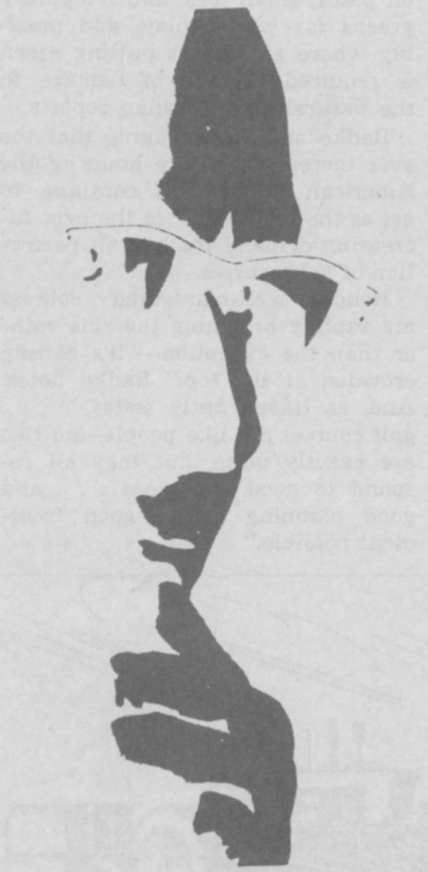
Budget control at The Greenbrier is achieved by comparisons with the preceding season's expenditure projection and its actual cost. Factors weighed in determining a budget include additional costs of materials and equipment, and a detailed breakdown in labor costs incurred in the various operations, Haven said. Inasmuch as about 1,000 man-hours have been consumed during winter months in scraping and brushing equipment for all three courses, Haven reported, Greenbrier officials are considering the purchase of new equipment with a view to decreasing man-hours and increasing maintenance efficiency.

Radko observes that more of today's courses are leaning toward artificial turf. Reasons for this are that the increasing usage of golf carts creates correspondingly more maintenance problems—i.e., harder wear on the turf, plus the necessity for installing more paths.

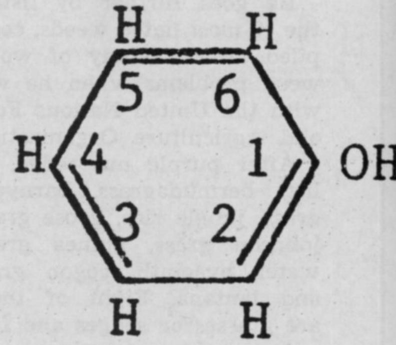
A Tennessee course is currently pioneering the use of artificial turf on paths, small tees, and temporary greens for winter play, and possibly where an instant putting green is required because of damage to the natural green, Radko reports.

Radko and Haven agree that the ever increasing leisure hours of the American public will continue to act as the major spur to the ever increasing demand for overall perfection of golf courses.

Hence, well-manicured courses are rapidly becoming the rule rather than the exception—"it's getting crowded at the top," Radko notes. And, as Haven aptly states, " . . . golf courses are like people—no two are exactly alike, but they all respond to good treatment . . . and good planning makes good treatment possible."



What Type 2,4-D To Use?



By J. S. COARTNEY and A. H. KATES
Extension Specialists, Plant Physiology
Virginia Polytechnic Institute
Blacksburg, Virginia

TO USE 2,4-D or not to use 2,4-D. That is only part of the question. Another consideration is what type of 2,4-D would be best suited for the job.

All kinds of the chemical have the same basic weed-killing ingredient, but are formulated for different purposes. They can be divided into major groups: acids, salts, amines, esters (high and low volatile), and oil-soluble amines.

In addition to 2,4-D, there are several other closely related compounds considered as derivatives of phenol and hence named phenoxy herbicides. These include 2,4,5,-T, silvex MCPA, 2,4-DB, and others.

Comparing the molecular structure of 2,4-D with that of phenol (Fig. 1), you can better visualize how the chemical name is developed.

The phenol ring is numbered for convenience. Each angle of the ring represents a carbon atom. By observing the two molecules you can see the chlorine atoms have been substituted on the ring at the 2 and 4 position and a 2 carbon unit (acetic acid) has been added. 2,4,5-T is identical with 2,4-D with the exception of an additional chlorine atom substituted at the 5 position of the ring.

Growth-regulatory and weed-control potentials of 2,4-D were discovered in the early 1940s. Early information on the use of 2,4-D was classified during the war.

Although a tremendous amount of research has been conducted with 2,4-D, it still is not clear how 2,4-D kills plants or why it is selective for broadleaf plants.

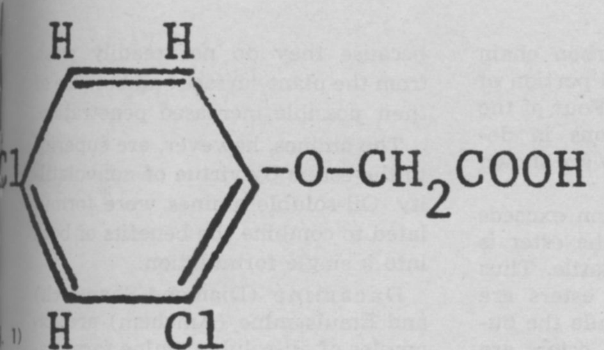
Studies have shown that many plant processes are affected by 2,4-D. Respiration, food utilization, cell division and cell enlargement are all increased after application.

Recent work would indicate that it has a more basic action which is an effect on the nucleic acids of the cells. The nucleic acids contain the information for directing cell processes. Disrupting this system can cause many side effects.

The common expression that 2,4-D causes a plant to grow itself to death may be as near the truth as any present scientific explanation.

The 2,4-D applied to a plant leaf must gain entry to be effective. Once inside, it may be moved through the plant. This movement is called translocation and is responsible for the root kill of many deep-rooted plants.

Movement occurs in the living tissue, which carries food throughout the plant. When excessive rates of 2,4-D are applied or other materials added to give a contact burn, living tissue is destroyed and translocation into the root system is reduced or prevented.



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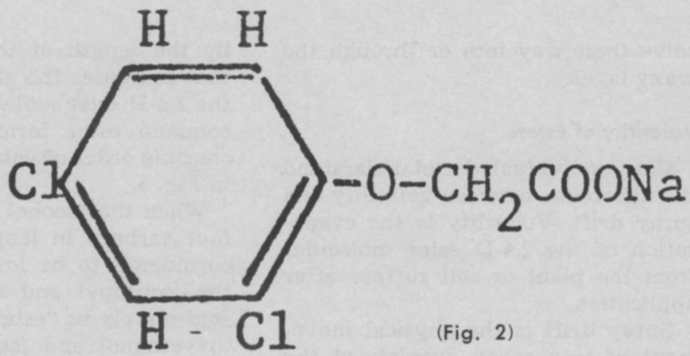


(Fig. 2)

Thus, addition of oil to a foliar spray of 2,4-D and/or 2,4,5-T will hasten top kill but excessive regrowth may occur.

2,4-D also is used as a pre-emergence herbicide. Again its action is primarily selective for broadleaf weeds. Under ideal conditions, some control of emerging grasses may be realized. Duration of 2,4-D in the soil is short and usually does not exceed four weeks. Loss from the soil is primarily by the action of soil microorganisms.

Formulations of 2,4-D

The pure acid of 2,4-D has very low water solubility but may be dissolved in various solvents or suspension agents that can mix with water. Amchem's Weedone 638 is an example of an acid formulation of 2,4-D.

Various salt formulations of 2,4-D are on the market. These appear as white powders that dissolve in water. Fig. 2 is the sodium salt, but others include the potassium, lithium, and ammonium salts.

Amines and esters are by far the more popular formulations. The amines are more accurately known as amine salts, since they combine an amine grouping with one of the above salts.

Amines are ammonia (NH_3) derivatives with hydrogen atoms replaced by alcohol groupings. Methanol (CH_3OH) and ethanol (CH_3CH_3OH) are common substitutions. Fig. 3 is a common commercial formulation, triethanolamine salt of 2,4-D.

Amine salts are quite soluble in water and form true solutions when added to a spray tank. The amine salts as well as the salt formulations dissociate in the spray tank as shown in Fig. 4.

Thus if other salts (calcium and magnesium in hard water, or others in liquid fertilizer) are present, reactions may occur which will result in insoluble precipitates. Such precipitates can clog sprayers and are extremely difficult to remove.

Amine salts and salts are nonvolatile and do not evaporate after reaching the plant or soil surface. Where high temperatures (excess of 80 degrees) are expected or when applications are in close proximity to actively growing sensitive plants, the amines should be used in preference to ester formulations.

A disadvantage of the amines is their water solubility, which allows them to be washed from the plant surface by rain. As a rule, the majority of the applied 2,4-D which is going to enter the plant will have done so in the first six hours. Thus if an amine salt formulation remains on the plant for at least six hours prior to rain, no serious loss of effectiveness should occur.

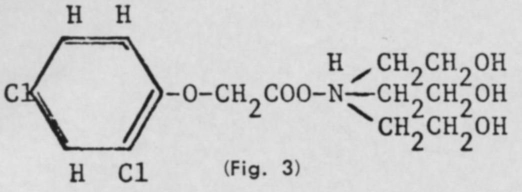
An ester is formed by combining an alcohol with an acid. The resulting ester receives its name from the alcohol used. Thus 2,4-D acid combined with butyl alcohol yields butyl ester of 2,4-D as shown in Fig. 5.

Esters are soluble in organic solvents and nearly insoluble in water. Commercial ester formulations are dissolved in oil carriers with an emulsifier. When added to water in the spray tank, they form emulsions of tiny oil droplets (containing 2,4-D) dispersed in water. Such a dispersion creates a milky appearance rather than the clear (but colored) solution which results when an amine salt is added.

When esters are sprayed on a plant surface, the water evaporates and leaves a thin film of oil containing 2,4-D. As esters are oil soluble rather than water soluble, they do not wash off as readily during rain.

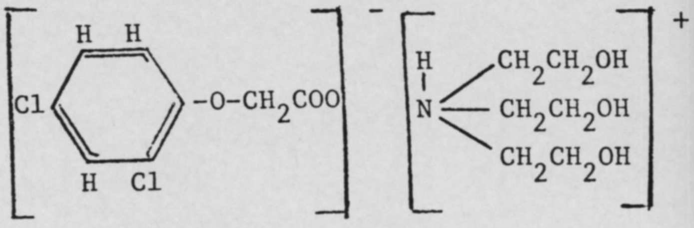
Esters are also considered to have greater killing power than amines on certain plants. (On some woody species, the amines may be superior to esters.) This is thought to be partially due to the presence of the oil carrier, which permits increased penetration of esters.

Leaf surfaces are covered by a waxy substance called cutin. The oils containing 2,4-D can conceivably dis-



(Fig. 3)

(Fig. 4)



solve their way into or through the waxy layer.

Volatility of Esters

Many individuals do not understand the difference between volatility and spray drift. Volatility is the evaporation of the 2,4-D ester molecules from the plant or soil surface after application.

Spray drift is the physical movement of tiny spray droplets at the time of application. Spray drift is dependent upon wind velocity, droplet size, and distance to ground. Droplet size is primarily controlled by pressure, nozzle size and design, and nature of material being applied.

Most cases of injury are from spray drift, and not volatile vapor drift. All formulations can result in spray drift when misused.

Ester formulations vary widely in their degree of volatility. Volatility of 2,4-D esters is primarily controlled by the length of the carbon chain that composes the alcohol portion of the 2,4-D ester molecule. Four of the common ester formulations in decreasing order of volatility are shown in Fig. 6.

When the alcohol portion exceeds four carbons in length, the ester is considered to be low volatile. Thus the isopropyl and butyl esters are sold merely as "ester" while the butoxyethanol and isooctyl esters are sold as low volatile esters.

The high volatile esters have been outlawed in many states. At temperatures in excess of 100 degrees, volatilization of the low volatile formulations becomes significant.

As leaf or soil temperatures exceed air temperatures, we suggest that low volatile esters not be used when air temperatures exceed 80 degrees.

Oil-Soluble Amines

Esters may be superior to amines because they do not readily wash from the plant surface and because of their possible increased penetration.

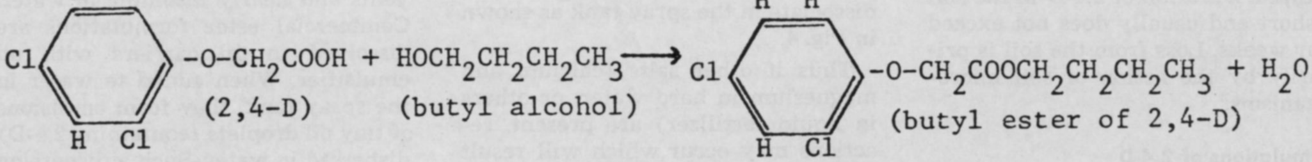
The amines, however, are superior to the esters by virtue of nonvolatility. Oil-soluble amines were formulated to combine the benefits of both into a single formulation.

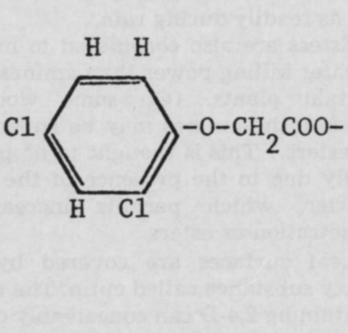
Dacamine (Diamond-Shamrock) and Emulsamine (Amchem) are examples of oil-soluble amine formulations of 2,4-D.

The disadvantages of the oil-soluble amine formulations are their higher cost and syrupy consistency which makes them difficult to pour from containers at cool temperatures.

Data comparing drift potential of oil-soluble amines with that of water soluble amine or ester formulations are not available. However, drift potential is anticipated to be equal to that of other formulations.

(Fig. 5)





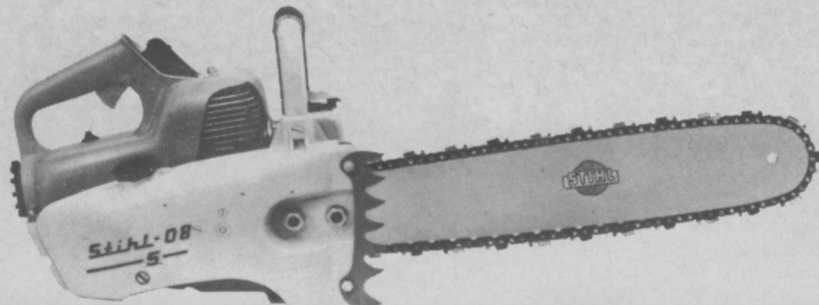
(Fig. 6)

a) $CH(CH_3)_2$ (isopropyl)

b) $CH_2CH_2CH_2CH_3$ (butyl)

c) $CH_2CH_2\text{-}O\text{-}CH_2CH_2CH_2CH_3$ (butoxyethanol)

d) $CH_2CH_2CH_2CH_2CH_2CH(CH_3)\text{-}CH_3$ (isooctyl)



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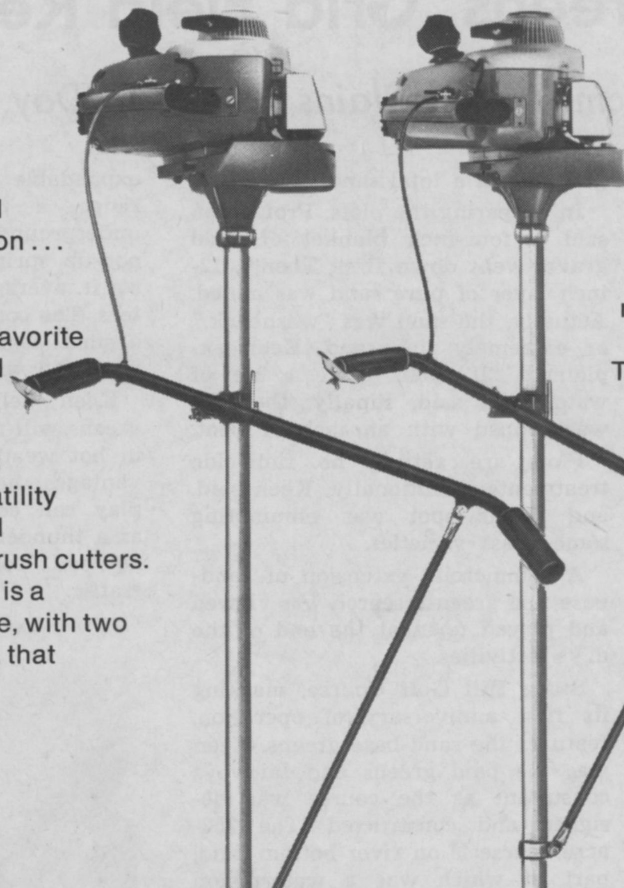

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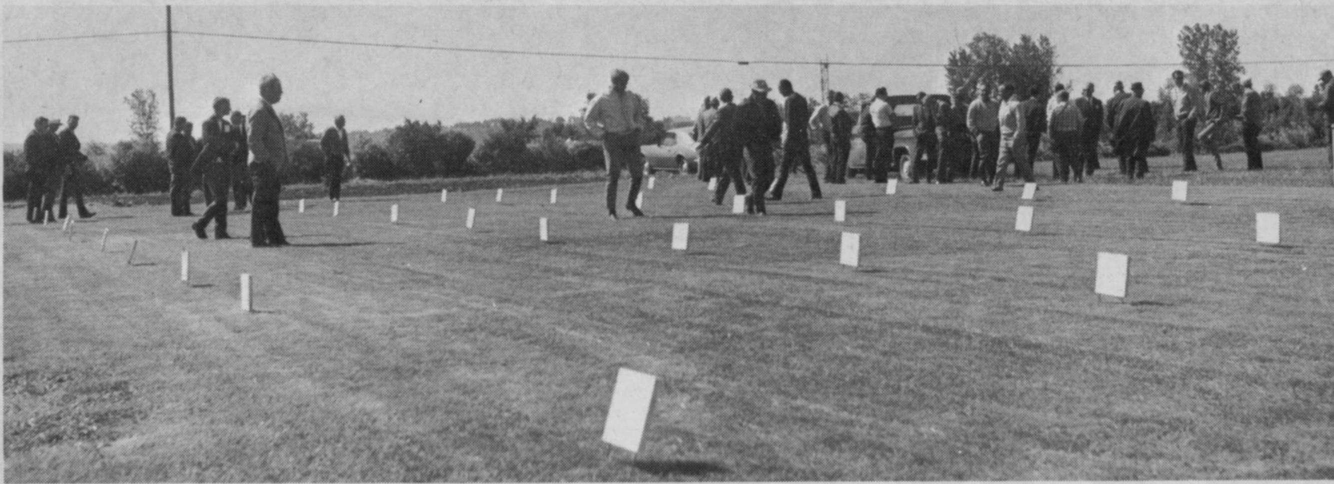

Golf course superintendents, sod producers, nurserymen and garden center owners stroll over grass research plots during the Central Plains Turf Field Day at Kansas State University. These are 55 plots of 26 varieties of bluegrasses and fescues.

Sand-Based Greens, Grid Field Renovation

Report from Central Plains Turf Field Day

WILL A TOTAL sand base support a turf golf green? What's a good way to establish and renovate a football field?

Are nitrogen compounds practical as herbicides?

A little more than 50 turf specialists came to look at these questions and study the answers at the June 2 Central Plains Turf Field Day at Manhattan in the shadow of Kansas State University.

The sun came for looks only. Visitors shivered in early morning temperatures from the mid 30s to mid 40s that equalled or surpassed all-time low records in many parts of the Midwest.

The spring coolness followed one of the more severe winters the region has experienced. "We've had the worst ice crust since '35," reported Ray Keen, professor of horticulture at K-State, shortly after he greeted guests on the grounds of the university's turf research plots.

Bermudagrass varieties, being grown to see which are adaptable to the area, told the story. So severe was the winter that it killed the "sissy Bermudagrasses" to the extent of reducing varieties being considered from 270 to 24.

"That's good," Prof. Keen told the group. "It means those varieties won't be dying on your golf courses later on."

Golf Greens on Sand Base

Interest was intense concerning some 50 varieties of bentgrasses growing on a total sand base.

In preparing the plots, Prof. Keen said a four-inch blanket of road gravel went down first. Then a 12-inch layer of pure sand was added. Actually, the sand was "washback," or extremely fine sand, Keen explained. "It holds quite a bit of water," he said. Finally, the plot was topped with an inch of peat.

Plots are getting no fungicide treatments intentionally, Keen said, and dollar spot was eliminating some grass varieties.

A commercial extension of sand-base turf green research was viewed and played upon at the end of the day's activities.

Stagg Hill Golf Course, marking its first anniversary of operation, features the sand-base greens. Keen was the paid greens and fairways consultant as the course was designed and constructed. The 352-acre course is on river-bottom land, part of which was a watermelon and cantaloupe farm at one time.

The course has 18 holes and is expandable to 27. It has a driving range, a putting clock, and an underground sprinkling system with pop-up sprinklers to tend the 5000 sq. ft. average greens and extra-size tees. The course incorporates a lake, a small lagoon, and most fairways are lined with 50-ft. trees.

Keen believes the sand-base greens will need a little more water in hot weather. But off-setting advantages, he pointed out, are that play can continue almost as soon as a thunderstorm quits and there's no soil compaction from heavy traffic.

Tom Shackleford, who's responsible for K-State's grounds, explains (right) how improperly mixed soil led to a compacted surface at the new K-State football stadium. He was impressed with coverage attained by Windsor and Fylking bluegrasses since planting this spring. On the next page, visitors are inspecting the field's soil composition and turf coverage.