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HERBICIDES --- CHEMICALS FOR CONTROL OF VEGETATION ON GUAM
by Paul B. Souder

A plant species which is desirable under one set of circumstances may become highly undesirable under slightly different conditions. In the wrong area all types of vegetation from trees to microscopic plants may be weeds, vegetation that needs control.

A survey of installations on Guam indicates that the types of areas involved in the undesirable vegetation problem fall into three fundamental categories:

- (1) Control of weeds and brush on unimproved grounds - elimination of tangantangan and brush along road and utility line right of ways;
- (2) Control of weeds in turf grasses - burr grass, sensitive plant and wild daisy removal in lawn areas; and
- (3) Control of weeds and brush on semi-improved grounds - antennae fields, airfields, igloos, storage areas, e.c.

The control of weeds and brush on unimproved grounds is limited to work necessary to prevent a return of undesirable trees and brush to open areas. This control can be accomplished by mowing or spraying once or twice a year.

Highway weed control emphasizes the diversity of this problem. Weeds along road shoulders threaten to break up the pavement surface and interfere with drainage. They may make the surface slippery. It takes a good deal of manpower to trim weeds and grass around guardrails, culverts, signs and signals, bridge approaches, and traffic islands. In such locations, vegetation may be a safety hazard and an eyesore and may shorten the life of pavement, curbing and wood or metal fixtures. In dry months, vegetation along the road may be the tinder that spreads fire from a carelessly discarded cigarette or match. Furthermore, weeds and grass may catch windblown rubbish, keeping the roadside cluttered.

Another weed problem is frequently found along drainage ditches, where vegetation clogs the ditch, interfering with

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the flow of water. Since the ditch bottom cannot usually be mowed, digging and scraping is the only alternative. But this also is a costly hand operation. Worse than that, shoveling and scraping soon cuts away enough elevation to change the flow of water. Here, of course, we are making a distinction between rank weed growth, which is an obstruction in the ditch, and a good sod bottom where each blade of grass acts as a little check dam to prevent erosion and silt deposits.

In the control of weeds in turf grasses (on lawns, parks and other improved areas) much of the necessary weed control can be achieved by well regulated programs for fertilizing, mowing, watering, and control of insects and diseases. Inadequacies in any of these may cause a weakening of the turf grasses, with subsequent weed invasion.

The control of weeds on semi-improved grounds, can usually be accomplished by mechanical mowing, which should prevent invasion of an area by trees and brush, and which should protect grass from excessive shading, which may kill it. Turf here is used for soil stabilization where a trim appearance is not so essential.

Economically the problem of weed and brush control along right of ways (highway, powerlines, and drainage ditches) in open storage and fuel storage areas and weed control in ornamental turf (home lawns, golf courses, institutional grounds, communication areas and airfields) throughout military reservations, has consumed enormous amounts of time, labor, and public funds.

The control of weeds is therefore a serious matter to nearly everyone, since their effects are felt directly or indirectly. There are several methods of weed control which parallel the general methods of insect and disease control. Mechanical methods, such as cultivation, mowing, hand pulling, flooding, smothering by nonliving materials, pasturing, and turning, have all been used in the past. Biological methods are frequently used, especially employment of competitive and smother crops to suppress weed species. Insects have been highly useful in the control of cacti.

Chemical methods of weed control have been used for many years. Alone or in combination with other methods, they are extremely efficient. Chemicals used to destroy plant life are called herbicides, and they are usually classified into two broad groups. Nonselective herbicides are chemicals which destroy plant life in general without regard to species.

Selective herbicides are selective in their action, as the name implies, and may be used to control specific undesirable plants without serious damage to desirable species growing in the same area.

The problem of destroying all plant growth on a given area is relatively simple. There are a number of efficient non-selective herbicides from which to choose. On the other hand, the selective destruction of one plant species without harming other species growing contiguously is considerably more difficult. The killing of burr grass in a lawn without damage to the remainder of the grass is an example of this type of problem. Both the burr grass and desirable grass plants have many characteristics in common. It is only by utilizing some characteristic which they do not share that it is possible to effect selective killing. Such characteristics may involve the size of leaf, type of leaf surface, susceptibility to specific chemicals, or other physical or physiological property. By the careful regulation of the concentration of chemicals, it is often possible to turn a non-selective herbicide into one which is selective, since the lethal doses for different plants vary considerably. The choice of the proper chemical for a particular weed-killing problem may thus be simple or complex, depending upon guides one may have to follow, few of which exist on Guam.

Whether it is desired to eradicate scrub growth along roadways, remove brush from utility and pipeline right of ways, and remove woody growth from cleared land, many factors must be considered.

Some methods use chemicals more effectively than others, requiring a minimum of application. Some methods are easier and cheaper to perform from the standpoint of labor needed. Different species show variations in ability to withstand treatment by different methods. The choice of application method may depend upon the size of the weed trees, number of stems or amount of brush, quantity and size of desirable trees, availability of suitable labor and equipment, and finally - the end result desired.

Economics in a direct fashion holds the key to rapidly expanding interest in herbicides. As "hoe labor" becomes less available and more expensive, selective herbicides acceptance and demand mount among users throughout the world.

The selectivity in selective herbicides may mean many levels of weed killing activity. In some cases overuse of

a selective herbicide will kill all vegetation, while in others general contact killers carefully used will have a selective action. Selectivity of application will often substitute for or supplement chemical activity of herbicides. For example, oil directed at the base of ornamental shrubs will control small weeds, but if oil hits the leaf of the shrub, then it too is killed.

Preemergence herbicides sprayed after planting will stop weed seeds, normally lodged close to the soil surface, from germinating and will do so without harming crop seeds planted 1½ to 2 inches deep. Solubility of the herbicide will influence activity, also; the less soluble chemicals remain near the soil surface and control shallow germinating weed seeds but do not reach deep plant seeds or root crops.

If a plant crop possesses a very different structure and growth habit from those of weed plants present, control of the weeds in the crop's presence may take advantage of some or all of these differences. Some herbicidal formulations that will wet or stick only to weeds and not to crops have been used extensively. Cereals have corrugated waxy leaf surfaces which are narrow and generally almost vertical, making retention of a herbicide difficult. The smooth, broad, nearly horizontal leaves of many weeds, on the other hand, permit easier coverage by and retention of herbicides and eventual killing of the weed plant.

The exposed growing points of broad-leaved plants allow easy contact by herbicides during any stage of life, as contrasted with the protected growing points of narrow-leaved plants. Cereals, for example, have their growing points located in the plant crown which remains in a protected position below the soil surface. Other plants have a dormant period during which herbicides have little effect. During this dormancy, applications of herbicides to control annual weed plants may be made without crop damage.

The selective herbicides used in largest quantity take advantage of differences in plants' tolerance to toxic chemicals. These chemicals which can produce many physiological responses in plants - hence their general name of "growth regulators" - are receiving most research now. These plant hormone chemicals have definite limitations and will cause serious damage to desirable plants if improperly used. Environmental conditions often cause selective herbicides to perform inconsistently, giving rise to charges that they are unreliable. Some (2,4-D for example) have highly volatile forms which may drift to fields

adjacent to sprayed fields and cause crop damage.

Another method for obtaining selectivity of herbicides has been recognized. It utilizes the ability of certain plant enzymes to control chemical reactions which convert inactive compounds to ones that will produce growth responses in plants. The process, beta-oxidation, can be shown to break down certain compounds within the tissues of one plant species and not in another. 4-chloro, 2,4-dichloro-, 2-methyl-4-chloro-, 3,4-dichloro-, and 2,4,5-trichloro-derivatives of gamma-phenoxy-butyric acid have been tested. These compounds are related to the derivatives of gamma-phenoxyacetic acid - MCPA and 2,4-D. Susceptible plants possess enzymes which convert butyric to acetics, killing the host plant. Certain of these butyrics are acceptable weed killers for weed control with such crops as clover. If MCPA or 2,4-D is used for weed control here, serious damage results.

Evidence indicates that soil microorganisms degrade the butyric acid derivatives to acetic acid derivatives, if washed off plants by rain or if applied to soil. Damage to crop plants may then result through absorption through the roots.

Butyric derivatives should be more effective because they will translocate more readily (being non-toxic at first) and accumulate in greater amounts in plant tissues before conversion to acetics. Some plant pathologists point out that 2,4-D kills too quickly in perennials, interfering with translocations, and permitting regrowth.

The use of proper chemicals by qualified personnel has resulted in a substantial improvement in weed control, especially where all vegetation is considered undesirable for fire hazard reduction purposes. Where mechanical (or hand) weeding and chemical methods have been compared, chemical control usually has given better results with much less average cost per unit of area treated. Although it may seem expensive to go over the ground once with the proper chemicals, the long-term cost, as reported, has been much less than that of mechanical or manual clearance because the chemicals used killed not only top growth but also most roots. When roots were killed the time between treatments was greatly extended and follow-up retreatments with selected soil-sterilant chemicals usually cost much less than the original application.

In using herbicides certain rules are in order:

(1) Read the directions: Each manufacturer sells a different mixture, so naturally the correct way to apply the product varies. Most weed killers for lawns contain 2,4-D, mercury, or potassium cyanate. Each must be used in a specific way. For tangantangan there are AMS, Brush Killers, and certain oils. Each requires different procedures.

(2) Use the right amount: The chemicals are so potent that a very small amount is enough. Apply enough to kill the weeds, but not enough to injure the lawn grass. So measure accurately! Too little of the chemical--weeds stay healthy; too much poison--grass also killed. Follow the directions and you will get perfect control. The old adage, "If a little is good, more is better", definitely does not apply when using weed killers.

(3) Wait until weeds are growing actively: 2,4-D must be absorbed by the leaves and this happens readily only when the weed is growing. Wait for warm, sunny weather, but do not apply when drought has checked plant growth. If your lawn is starved, the weeds will be growing so slowly they won't absorb much poison.

(4) Choose a calm day: Wind is dangerous because the drift of fine dust or spray can travel to nearby flowers (even for a mile or more sometimes) and kill or injure every plant it touches. Most brands are perfectly safe to use except on breezy days. A few brands of 2,4-D are especially volatile, so are never safe immediately next to flower beds. (Read the directions.)

(5) Clean the sprayer: Any overlooked residue of 2,4-D will make any later use of the sprayer lethal to your garden flowers and vegetables. Either scrub the sprayer thoroughly after each use for weed killers, or better still, reserve a special sprayer just for weed killers. A kerosene rinse, followed by three changes of water, is the minimum to do a safe cleaning job. Don't forget to run these through the hose and nozzle, too. Also avoid contaminating garden supplies, such as plant food and insect killers.

(6) Be patient: Most of the chemical weed killers don't have a single lethal punch that brings sudden death. Rather, the weeds decline slowly. Except for a progressive curling of the leaves, you can't see that anything is happening until one day, several weeks later, you realize the weeds have vanished!

(7) Don't mow for five days: You want the roots killed, too, not just the leaves - so allow time for the chemicals to move down the leaves. Mowing after dry powders are applied is especially bad because the fanning of the blades blows the chemical off the weeds.

(8) Follow approved schedule of treatments: These chemicals are not one-shot treatments. Timing of follow-up is important - too close may kill lawn grass, too far apart lets weeds flourish. Usually three treatments are needed (see the brand directions).

Chemical herbicides have been applied to weeds, trees, or brush in just about every imaginable way - to the foliage, to the bark, on wounds, on stumps, in notches, in frills, in slits, or on soil. Any method will work as long as it introduces enough toxic material into conducting tissues of the plant.

For application on foliage, the proper season or stage of growth for spraying woody plants is very important. Soil moisture must be adequate for appreciable shoot or root growth if good kills are to be obtained. Since soil moisture conditions are not entirely predictable, a considerable amount of personal judgment must be involved. Such factors as rainfall, slope, soil depth, abundance of vegetation on the site, root-shoot ratio (old plants versus sprouts following cutting), root distribution, and soil fertility all influence the availability of water within a plant. With ground equipment spray applications may be (1) made broadcast, by employing a boom for completely spraying the entire area uniformly, or (2) made to individual plants or areas, making sure complete coverage is accomplished.

Dormant sprays are usually used only on deciduous woody plants, completely covering stems by a power sprayer and a mixture of oil as the diluent. This method can be used in dense brush where other sensitive plants exist.

With basal sprays, chemicals are used in concentrated form on the lower parts of the stems of woody plants. Best results are obtained on soils that are neither excessively wet or dry. Cover all sides of the stems near the ground line, using a solid-cone spray, and apply enough to have runoff at the base into the soil. Apply 2 to 3 fluid ounces of spray mixture for each inch of stem diameter. Stems larger than two inches in diameter should be filled or cut into near the base and the spray mixture applied liberally to the cuts.

Cut surface treatment is used for elimination of trees.

Stump treatment utilizes the same basal spray solution, applying it to the top of stumps as well as to all sides to the ground line, with runoff into the soil. The cut surface or painting and daubing method may be also used for stump treatment.

Soil applications may be applied by sprayer or in dry form. Chemical herbicides may be extended with water, oils, wetting agents, and emulsifiers. Water is generally the primary diluent for foliage sprays. Oils may be used alone or in emulsion in the spray mixture. Diesel oil and kerosene are most common. For basal sprays oil is used alone as carrier of 2,4-D and 2,4,5-T esters. For foliage sprays it is commonly added in small amounts to increase penetration of leaves, bud scales, and bark.

Too much oil on leaves (more than 1 percent or more than 1 gallon per acre) appears to increase the amount of burn and to hinder the movement of the chemical. Where very few photosynthetically active leaves are present, the use of straight oil is good practice. Results are inferior, however, to those obtained with proper application of foliage sprays when the plants are quite active photosynthetically. Where oils are added to ester formulations, it is important to mix the oil with the ester before adding water.

Wetting agents and emulsifiers may be added to increase the effectiveness of the sprays. In general ester formulations have adequate emulsifier in them. However, if a poor emulsion is obtained, add 4 ounces of emulsifier or household detergent per gallon of commercial ester formulation. Aqueous solutions of AMS require these additives for best results. The best type of emulsifier to be added can not be clearly defined (non-ionic type is suggested) except that it should result in proper emulsification of the materials and that it should be relatively non-toxic to leaves at the concentrations used.

Herbicides may be classified according to the method of application as follows:

Soil Application

Non-selective--kills all types of plant growth.
Temporary effect.
Extended effect--few weeks to several years.

Selective--injurious to some plants or types of plants and non-injurious or slightly injurious to others. Is a matter of relative degree of injury. Value lies in being injurious to undesirable plants (weeds) and non-injurious to crop plants. Selective action may be due to tolerance on the part of the crop plant, to placement of herbicide in soil, or combination of both. Soil treatments of the selective type are usually in the nature of pre-emergence application, that is, applied after the crop is planted but before it emerges. However, the application may be made before planting (pre-planting) or after emergence (post-emergence), frequently by directed spray.

Foliage Application

Non-Selective

Contact--kills tissue actually contacted.
Translocated--applied to foliage is translocated to other portions of the plant where tissue is injured or killed. Action is usually slower than direct contact, desirable to permit absorption and translocation by the leaves and stems down into the roots.

Selective

Contact

Translocated

The action of herbicides on Guam vegetation will be reviewed, proceeding from simple inorganic compounds through complex organics.

1. Halides, Inorganic

a. Sodium chloride, NaCl, non-selective. Oldest of soil sterilants. Frequently used on paths, driveways, and on areas where it is desired to eliminate all types of vegetation. Salt kills plant tissue by plasmolysis, so fairly large quantities required to produce desired effect. Is freely soluble in water and readily leached from soil, with resultant transient herbicidal effect. 0.5% solution plus 0.25% wetting agent (Tide) showed no herbicidal effect on Guam lawns except to cause red coloration of plants treated. Potassium chloride showed no herbicidal effect in a 0.5% solution with 0.25% wetting agent.

- b. Sodium fluoride, NaF, killed 95% of grass population in 1% solution with .5% wetting agent (Tide) when applied to Guam turf. Killed 60% of grass population in .5% solution with 0.25% wetting agent. No selectivity exhibited.
- c. Sodium bromide, NaBr, had no herbicidal effect on grass population in 0.5% solution with 0.25% wetting agent (Tide) when applied to Guam turf. Potassium showed no herbicidal effect at the same concentration with wetting agent.
- d. Sodium iodide, NaI, killed 50% of grass population after 30 days in 0.5% solution with 0.25% wetting agent (Tide) when applied to Guam turf, as did Potassium Iodide at the same concentration. No selectivity exhibited.

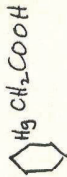
2. Sulfates, Inorganic

- a. Ferrous sulfate (iron sulfate, iron vitriol, copperas), $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$, selective herbicide against broad leaf weeds, less toxic to grasses and cereals. Apply five pounds per 1000 square feet, dissolved in water. Against lawn weeds apply dry with ammonium sulfate. Action slow, concentrations required high, more expensive and less effective than 2,4-D and arsenicals. It leaves a rusty residue on foliage and other objects, staining clothing, shoes, walks, ornamental monuments, etc.

3. Heavy metal compounds

- a. Cupric nitrate, $\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$, selective herbicide against weeds in lawns in 2% solution. May be applied dry. Kills by direct protoplasmic action like salts or other heavy metals.
- b. Cupric sulfate, CuSO_4 ; Cupric chloride, CuCl_2 ; and Cupric acetate, $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$, resemble cupric nitrate in action, but have been used less frequently as herbicides. A 2% solution of CuSO_4 killed 60% of turf vegetation after 30 days, on Guam. No selectivity exhibited.

- c. PMA, PMAC, PMAAS, Phenyl mercuric acetate, $\text{C}_6\text{H}_5\text{HgOOCCH}_3$, selective herbicide against broad leaf grasses. To control seedling plants and dormant grass dry, and not less than two inches tall at time of treatment. To control mature plants, apply at rate of 2 lb/300 sq. ft. On Guam when applied once only at rate of 1 lb/300 sq. ft. (100 gms per 25 sq. ft.) very little herbicidal activity shows on vegetation and no selectivity. Is more expensive than Potassium cyanate, which gives quick control of average infestation. PMA is less likely to cause tip burning of desirable turf material, but does poison animals. "TAT-C-LECT", "SELTOX", "PARATURF" are proprietary forms in liquid form, "SCUTT" is dry form. "Ortho Crab Grass Killer", of California Spray Chemical Corp., is \$.37 per pound (dry form); "Ortho Liquid Crab Grass Killer & Turf Fungicide" is \$1.95 per pint (liquid). Tag Fungicide. Phix is 22% soluble PMA manufactured by Chemley Products Co., at cost of \$4.40 per pound, used as a fungicide for apple scab control.



- d. Mercuric acetate, $\text{Hg}(\text{C}_2\text{H}_3\text{O}_2)_2$, on Guam when applied dry (500 gms per 25 sq. ft.) has little herbicidal effect, though swollen finger grass was killed after 30 days.

4. Chlorates

- a. Sodium chlorate, NaClO_3 , 115% water soluble, is a white crystalline salt which, applied dry, sterilizes the soil and, in water solution, can be used either as a general or selective contact herbicide, according to strength, which can vary from one to ten percent. It is normally used non-selectively, either as a general weed-killer or, on agricultural land, a few weeks before planting. Apply 15 lbs/1000 sq. ft., in dry form. In solution, is effective as a contact spray with same translocation. It is not as effective as sodium arsenate for land clearance. It is corrosive to metals. Chlorates are powerful oxidizing agents, and when mixed with organic matter, the combination becomes spontaneously combustible. Wooden structures, weedy

trash, shoes, and clothing if impregnated with spray material and dried are decided fire hazards. Is effective against all perennial weeds. Soil moisture and relative humidity markedly affect penetration of chlorate into soil. Soils which are heavier, poorly drained, rich in organic matter, high in nitrates, or alkaline, reduce effectiveness of chlorate as a herbicide. Vanadium pentoxide, and salts of Co, Mn, Ni increase effectiveness of the chlorate as a herbicide. Cost \$.12 per pound, Mfd Pennsalt, Chipman.

(1) Atlacide, 58% sodium chlorate, 40% fire retarding adjuvant. Designed to reduce fire hazard accompanying the use of straight sodium chlorate. Several fire retardants have been used. Calcium chloride was used for many years but was not effective when humidity dropped below 20%. Atlacide more costly to use than sodium chlorate since they cost the same per pound, and is effective in proportion to the chlorate contained. Mfd. Chipman.

(2) CBM, chlorate - borate mixtures

(a) Sta-Klor, 40% sodium chlorate plus 10% sodium trichloroacetate (NaCl_2O_2) plus 30% pentaborate decahydrate ($\text{Na}_2\text{B}_{10}\text{O}_{16} \cdot 10\text{H}_2\text{O}$). Effective against deep rooted perennials at rate of 4.5 lbs/1000 sq. ft.; as a spray at rate of 1/2 lb/1 gallon.

(b) Clorbor, 27.5% sodium chlorate, 44% sodium pentaboratetetrahydrate ($\text{Na}_2\text{B}_{10}\text{O}_{16} \cdot 4\text{H}_2\text{O}$), and 11% sodium tetraboratepentahydrate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$). Spray at rate of 15 lbs per 1000 sq. ft. against annual weeds, 50 lbs per 1000 sq. ft. for soil sterilization, and 25 lbs per 1000 sq. ft. for perennial weeds, at rate of 1 lb per gallon. Mfd. United-Heckathorn.

(c) Clorbor 42, 42% sodium chlorate, 40% sodium pentaboratetetrahydrate and 10% sodium tetraboratepentahydrate. Spray at rate of 10 lbs. per 1000 sq. ft. against annual weeds, 15 lbs. per 1000 sq. ft. against perennial weeds, and 30 lbs. per 1000 sq. ft. for soil sterilization at 1 lb. per gallon. Mfd. United-Heckathorn.

c. Ammonium chlorate, NH_4ClO_3 ; Barium chlorate $\text{Ba}(\text{ClO}_3)_2$; Calcium chlorate $\text{Ca}(\text{ClO}_3)_2$; and Potassium chlorate KClO_3 ; and Zinc chlorate $\text{Zn}(\text{ClO}_3)_2$, are not as satisfactory as the sodium chlorate as herbicides.

Boron compounds, non-selective soil sterilants, non poisonous.

- a. Borasch, regular (Borax), (sodium tetraborate decahydrate), $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$. An impure form of borax containing the equivalent of 34% B_2O_3 (boron oxide). Low solubility (about 0.1 pound per gallon water). It is applied dry at about five times the rate of sodium chlorate or 120 lbs per 1000 sq. ft. Rate will vary with the purpose and type of soil. No fire hazard, and because of insolubility remains in soil for a long time. Not too effective on most deep-rooted perennials because it tends to stay in upper layer of soil. Desirable for control of weeds around inflammable structures such as wooden buildings, lumber yards, stockyards, oil tank farms, munition dumps, etc., where surface sterilization against shallow rooted weeds and grasses is desired. Cheap per pound but, at present prices, cost per acre is higher than sodium chlorate because of quantity required.

b. Borasch, concentrated, (sodium tetraborate). Similar to regular borasch but, with water removed, containing 61.5% B_2O_3 equivalent. Otherwise acts the same. Costs somewhat more per pound but may be cheaper to use because only about half as much required. Saves materially on freight and labor involved in application.

c. BDM, Borate, 2,4-D mixtures.

- (1) Borax DB spray powder, complex of sodium borate (NaB_2O_4) containing 59.5% boron trioxide and 7% 2,4-D acid equivalents (dichlorophenoxyacetic acid), ClC1=CC=C(C=C1)C(=O)O. Nonselective soil sterilant, soluble in water up to 2 pounds per gallon. Apply 6 pounds per square rod for deep-rooted perennials. The presence of the borate retards the breaking down of the 2,4-D, increasing its effectiveness.

(2) Borax DB granular, $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ (40.0% boron trioxide and 7% 2,4-D acid equivalents). Recommend the same as for the spray powder, except apply in dry form.

(d) Polybor chlorate, 73% disodium octaborate ($\text{Na}_2\text{B}_8\text{O}_{13} \cdot 4\text{H}_2\text{O}$), 25% sodium chlorate. Spray at rate of 10 lbs per 1000 sq. ft. against perennial weeds, 20 lbs per 1000 sq. ft. against for soil sterilization. No fire hazard. Mfd PacBorax. Cost \$0.09 per pound.

(e) Polybor-chlorate 88. Similar to polybor chlorate, somewhat less potent with 36% equivalent and 22% sodium chlorate. Little justification for manufacture in view of similarity to polybor chlorate.

(f) Chlorax, 52% sodium pentaborate tetrahydrate and 42% sodium chlorate. The 36% B_2O_3 equivalent and 42% sodium chlorate should provide a somewhat more toxic soil sterilant than polyborchlorate and somewhat less should be required to produce similar results because of higher chlorate content. The comparative value from an economic standpoint will depend upon the cost per pound of each. Less soluble than polyborchlorate.

(g) Chlorax "40", 58% sodium metaborate ($\text{Na}_2\text{B}_2\text{O}_4$) and 40% sodium chlorate.

(3) CBMM, chlorate - borate - monuron mixtures.

(4) CBFM, chlorate - borate - fenuron mixtures.

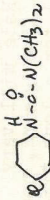
(5) CBDM, chlorate - borate - diuron mixtures.

b. Magnesium chlorate, $\text{Mg}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$. Presents less fire hazard than sodium chlorate, and hygroscopicity keeps it in effective state. Defoliant. Corrosive to metals. 50% water soluble.

- (1) E-Z-Off, 18.15% Magnesium chlorate. Mfd Gen Chem
 (2) Magron, 40% Magnesium chlorate. Mfd Dow Chem
 (3) M C Defoliant, 58% magnesium chlorate. Mgd Niag
 (4) Ortho M C, 58% magnesium chlorate. Mfd Cal Spray
 (5) De-Fol-Ace, 58% magnesium chlorate. Mfd Pennsal

d. Polybor (77% sodium pentaborate tetrahydrate and 18% sodium tetraborate pentahydrate). Contains 64% B₂O₃ equivalent. Offers distinct advantage where desired to apply in spray form, for is such fine powder that dry application is difficult. Should be more effective than borax against deep-rooted perennials because of solubility. Apply 55 lbs per 1000 sq. ft.

e. BMM, borate - monuron mixture, containing 63.2% disodium tetraborate pentahydrate, 30.8% disodium tetraborate decahydrate, and 4% 3(p-chlorophenyl) 1,1 dimethyl urea. Apply 5 lbs per 1000 sq. ft. for control of annual weeds, 10 lbs per 1000 sq. ft. for perennial weeds. Cost \$.23 per pound. Mfd Pac-Borax (Ureabor).



g. Gerstley Borate, mixture Ulexite (NaCaB₅O₉8H₂O) and Colemanite (Ca₂B₆O₁₁5H₂O). Apply 100 lbs per 1000 sq. ft. for annual weeds, 150 lbs per 1000 sq. ft. for perennial weeds. Cost \$.04 per pound. Mfd Pac-Borax.

6. Arsenicals

Very poisonous and must be handled with great caution, care being taken to keep away from livestock, children and wildlife. It is fatal to both humans and stock. Arsenic compounds have been used as plant poisons for many years. They enter the plant through the foliage and are carried to the root system by the sap stream. Destruction is rapid. In small doses they can be used selectively since certain plants are particularly susceptible. The sterilizing effect of arsenic on soils varies considerably according to the type of soil. It has least effect on earth rich in iron. Arsenic formulations should be used with precaution; operators should be protected from contact with or absorption of the product; stock should be enclosed; inexpensive equipment should be destroyed after usage, and sprayers cleaned thoroughly.

a. Sodium arsenite, mixture sodium ortho arsenite (Na₂AsO₃) and sodium meta arsenite (NaAsO₂). Sodium arsenite and arsenic acid are the best forms to use as selective weed killers in established turf. They

are most effective on clover, and the crabgrasses. Repeated applications also will kill, or effectively check many broad-leaved weeds. They, discolor and sometimes burn the grass if used at heavy rates in hot weather when soils are dry. The effects are temporary, and turf usually recovers within 10 days or two weeks after treatment. Sodium arsenite can be applied either wet or dry. Arsenic acid is a liquid and must be used as a spray. Approximately 1 quart of commercial acid (70%) is equivalent to 1 pound of sodium arsenite. Power sprayers are used for wet treatments. Dry applications usually are made in fertilizer with a fertilizer distributor. Wet applications may be preferable for roughs when fertilizers are not applied. Dry treatments are less drastic on grass and are more desirable for use on clipped turf.

Soils should have sufficient moisture to a depth of four to six inches for good growth of the grass. Rates of application vary between two and eight ounces to 1000 sq. ft. Wet treatments should not be in excess of a four ounce rate. Dry treatments may be heavier. Minimum quantities should be used on Bermuda grass when clipped. The lower rates are advisable when temperatures are high and soil moisture low; otherwise, discoloration of the turf will be severe and serious damage may occur. The number of treatments and the time between applications will depend upon the concentrations used and the effectiveness of initial treatments. If little grass is present and complete reseeding will be necessary, maximum rates that will give a quick cleanup can be used. Where there is an appreciable amount of grass, periodic treatments at lighter rates are best. Ordinarily two to three treatments will provide effective control of the less-tolerant weeds. Sometimes four to six applications are required on hard-to-kill weeds or when the growth is dense. Usually two treatments will be effective in checking seed formation by the annual grasses. If deep-rooted perennials present, combine with sodium chlorate for complete sterilization.

Sodium arsenite is effectively used for chemical brush clearance, either by paint brush application to incisions or rings, or by simultaneous spraying of trunks and roots with a 40% water solution. The ringing method seems to be the most effective. Soft

woods are most susceptible to the poison; the latex-types are more resistant. Sodium arsenite is also used for rehabilitation of coconut groves. Approximately one ounce of the product, poured into a hole drilled at the base of the trunk, is sufficient to poison rapidly a palm of 60 feet and more. This method has been extended to reforestation where it has likewise given excellent results.

Sodium arsenite is more effective herbicide against crab grass than Potassium arsenite. Both discolor lawn grass. Does not brown lawn as much as Potassium cyanate. The arsenite should be used on older tougher grasses. Mfd Pennsalt (Penite). Cost \$.16 per pound; and Miller 74% Kill-All. Cost \$1.35 per gallon (10 lbs As₂O₃ per gallon).

- b. Arsenic pentoxide. Its effect is more rapid than sodium arsenite and is, therefore, less dangerous to stock. It is very effective when applied in small quantity to split guava stumps.
- c. White arsenic, arsenious oxide, arsenic trioxide, arsenic, As₂O₃. Doesn't penetrate as deeply as the arsenite, but is more permanent because of greater insolubility. May have little effect first year. Apply at rate of 15 lbs per 1000 sq. ft. As₂O₃ when applied dry on Guam at 150 gms per 25 sq. ft. exhibited little herbicidal effect on turf after 30 days. Mfd Cal Spray Chem (Triox). Cost \$.86 per quart.
- d. Pax, 2.85% lead arsenate (PbAsO₄) mixture with 86.8% inert and some nitrogen fertilizer. Apply 20 to 25 lbs per 1000 sq. ft. to selectively destroy crabgrass without harm to other grasses. Nitrogen fertilizer additive appears to increase effectiveness of crabgrass control.
- e. Calcium arsenate (CaAsO₄), and Manganese arsenate (MnAsO₄) cause injury to other grasses when applied at rates higher than 15 lbs per 1000 sq. ft. Not as effective as lead arsenate. Mfd Chipman, General Chem, Calif. Spray Chem, Niagara. Cost \$.14 per lb.
- f. MAA, monomethylarsonic acid, CH₃AsO₃H₂.

g. DMA, Disodium monomethyl arsenate, Sodax, Na₂CH₂AsO₄, is the most selective of crab grass killers. Before use, water soil thoroughly. Spray before sun is up or going down. Mfd Am Chem Paint (Weedone Crab Grass Killer containing Sodax); Doggett-Pfeil Co. (Hydromix Liquid Crab Grass Killer); O. E. Linck Co. (D1-Met); Nott Mfg. Co., Inc. (Sodar plus 2,4-D); Sterns Nurseries (Miradox); Vaughns Seed Co. (Sodar); Vine-land Chem Co. (Crab-E-Rid); and Calif Spray Chem Co. (Ortho Liquid Crab Grass Killer) at \$2.65 per quart.

h. Arsenic acid, non-selective herbicide.

i. Benzeneearsonic acid, C₆H₅AsO₃H₂, is less effective than As₂O₅.

j. Dimethylarsinic acid, (CH₃)₂AsO₂H, is less effective than As₂O₅.

k. Sulfoarsenites, HO₃S₂AsO₂; Sulfoarsenates, (HO₂S)₃AsO₄; Sulfoxarsenates, (HO₄S₂AsO₄); Pyrosulfoxarsenates, (HS₂O₂)₃AsO₄; and Monothioamline arsenite, CH₃CH₂NH-AsO₂, have all been tried as herbicides but performance data is unavailable.

7. Sulfamates

a. AMS, Ammonium sulfamate, ammate, NH₄SO₃NH₂, is non-poisonous, non-combustible, and very soluble in water. May be applied to soil in solution or dry. In spray acts as contact, and, to some extent, as translocated herbicide. Non-volatile, woody plant killer. Not too effective against grasses. Non-selective. Apply by spray any time after brush reaches full leaf stage and until foliage discolors using 30 lbs to 50 gallons water with 2 cz. spreader sticker (non-ionic soapless detergent) per 50 gallons of spray mix to obtain good wetting and reduce run off on all foliage applications. On Guam 10 bls per 1000 sq. ft. is effective against tangartangan, breadfruit, kamachile. Has no effect on the coconut. Mfd. Dupont (Ammate X, a 95% salt, sold by Tropical Garden Farms, Guam). Cost \$.30 per pound.

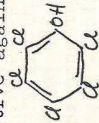
8. Cyanides, Cyanamides, Cyanates, and Thiocyanates.

a. Sodium cyanide, NaCN. Water soluble, very poisonous, non-selective.

- b. Cyanamids, Calcium cyanamide, CaCN₂. Selectively kills lawn weeds without injury to lawn grass. For pre-emergence treatment of soil apply 35 lbs per 1000 sq. ft. Moisture must be present for action as a defoliant or in pre-emergence treatment. Serves as nitrogen fertilizer after herbicidal effect. Mfd AmCyan (Aero-Cyanamid-Special-57% active ingredient).
- c. Monosodium cyanamid, NaHCN. Water soluble, very hygroscopic. Applied by spray. Useful in dry areas.
- d. Potassium cyanate, KOCN, aero-cyanate, crabrott, Select. Water soluble. Selective against broad or rough leaved weeds, and harmless to narrow or waxy leaved plants. Must be used on alkaline soils, unstable in acid. Is effective in crabgrass control, and post-emergence weed control in bulb type plants. Apply 30 lbs per acre for turf and lawns. Mfd Amcyan (Aero-cyanate weed killer, 92% active ingredient); Miller P-C Weed Killer (76% KOCN). Cost \$.64 per pound.
- e. Ammonium thiocyanate, NH₄SCN. Water soluble, non-combustible, non-toxic, non-selective, safest of the inorganic chemicals. 37 lbs per 1000 sq. ft. renders soil sterile for four months. Is a residual fertilizer. Acts by translocation. On Guam, a 4% solution gives total kill after 30 days, and serves as effective fertilizer thereafter.
- f. Sodium thiocyanate, NaSCN. Acts by translocation. Toxicity like ammonium thiocyanate. Calcium thiocyanate, Ca(SCN)₂, is less toxic than ammonium thiocyanate.
9. Halogenated Organic Compounds
- a. Chloronitrin, CCl₃NO₂, nitrochloroform, trichloronitromethane. Temporarily non-selective herbicide and soil sterilant. Does not support combustion or react with metals. Controls nematodes and other soil organisms. Costly.
- b. Methyl bromide, CH₃Br, non-inflammable, non-selective, temporary herbicide and soil sterilant. Controls nematodes and other soil organisms. Use 2 pounds per 100 sq. ft. Mfd Dow (Dowfume MC-2, 98% CH₃Br + 2% CCl₃NO₂ as warning agent). Cost \$1.00 per pound.

- c. Ethylene dibromide, $C_2H_4Br_2$, 1, 2-dibromomethane, EDB, a temporary non-selective herbicide and soil sterilant. Controls nematodes and other soil organisms. Use 9 gallons per acre. Costly. Mfd. Dow (Dowfune W-85, 83% by weight).
- d. Tetrachloroethane, $C_2H_4Cl_4$, 1, 1, 2, 2-tetrachloroethane, a temporary non-selective herbicide and soil sterilant. Controls nematodes and other soil organisms. Costly.
- e. "D-D" mixture, a combination of Dichloropropane, $C_2H_5CH_2CH_2Cl$, and Dichloropropene, $C_2H_3CH=CHCl$, a temporary soil sterilant and herbicide, non-selective. Controls nematodes and other soil organisms. Costly.
- f. Chlorobromopropane, CBP, $CH_2=CHCH_2ClBr$, water emulsions at high rates produce almost weed-seed-free seed beds. Residual effects very short.
- g. Monochloroacetic acid, $ClCH_2COOH$, a selective herbicide and defoliant. On Guam, 60% turf vegetation killed by 0.4% solution after 30 days. Non-selective, Nut grass unaffected.
- h. TCA, trichloroacetic acid, CCl_3COOH , 90% sodium ammonium calcium salts used which are water soluble and soluble in most organic solvents. Corrosive on metals. Most effective on grasses and is selective as a pre-emergence treatment for annual grasses, though not so effective as DCU. In the two to three leaf stage, grasses can be controlled with 10 to 20 lbs per acre, and even lower rates may be effective for pre-emergence application. For post-emergence application, grasses and perennials require 80 to 150 lbs per acre, and a second application for complete destruction. Is most effective when applied to light, moist soil. Light rains following application are beneficial, whereas heavy rains are likely to cause dilution and leaching, reducing killing action. 30 to 100 lbs per acre is insufficient to kill nut grass. 5 to 7 lbs per acre will control weeds in legumes (7 lbs per acre is injurious to legumes). Better effects can be produced by using smaller quantities of TCA, if it is mixed with 2,4-D, CADE, MCPA, or sodium chlorate. TCA is superior herbicide compared to salts. Mfd. Dow, Hooker, Monsanto, Standard Agricultural Chemicals (Santox Sodium TCA), American Chemical Paint Co (ACP Grass Killer). Cost \$.37 per pound.

- i. DCB, Ortho dichlorobenzene.
- j. TCB, Trichlorobenzene. 2, 3, 6-trichloro benzoic acid is effective against bindweed and deep-rooted perennial weeds. Mfd Heyden Newport
- k. PCP, Pentachlorophenol, Penta, is a non-selective, non-translocated, contact herbicide. The water soluble sodium salt, 85% NaPCP, is selective against broad leaf weeds and grasses. Selective action is function of ability to wet and penetrate leaf surfaces. On Guam dry pentachlorophenol has little herbicidal value at 2% concentration. As a residual herbicide, persistence in the soil enables it to destroy germinating seeds in upper layers, depending upon amount of dosage and environmental conditions. PCP would appear to decompose more rapidly in soils with a high humus content than in soils poor in organic matter. The microbiological optimum of soil conditions would seem to correspond to the lowest point of the herbicide's effectiveness.



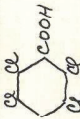
The Sodium Salt (Santobrite), however, is an excellent sterilant, applied dry, in 1% concentration, after 30 days. CADE is a chemically activated Diesel emulsion, incorporating Diesel oil and sodium pentachlorophenate, used as a contact herbicide. ARCADE has an aromatic oil substituted for the Diesel oil. A herbicide mixture containing 8 lbs NaPCP, 2 lbs acid equivalent butyl ester of 2,4-D, 2 pints Diesel oil, in 140 gallons water, applied 30 gallons per acre, gives good brush control. A pre-emergence spray of 25 lbs per acre NaPCP is required for elimination of weeds in legumes. Such a concentration is lethal to Cyperaceae, Amaranthus, Croliataria, Ipomea, Euphorbia hirta, Desmodium triflorum, Euphorbia prostrata, and Lantana camara.

6 CA-4 is a contact herbicide containing PCP and an aromatic distillate. CADE when mixed with TCA is more effective than either alone. Mfd Dow (Dowicide G, 85% NaPCP); Monsanto (Santopren 20 and Santobrite, NaPCP). Cost 40% \$.29 per pound.

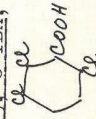
1. PBA, Polychlorobenzoic acid.

m. Dalapon, 2, 2-dichloropropionic acid, $\text{CH}_2\text{CCl}_2\text{COOH}$, 85% water soluble, sodium salt formulation. Translocated grass growth regulator. More selective than TCA in control of annual grasses in low dosage. Is lethal to grasses, but broad leaf species not affected. 1/2 lb per acre controls weeds in legumes when applied one week after emergence (4 lbs per acre is injurious to the legume). As a pre-emergence herbicide, completely controls grasses plus approximately 2% of weeds. In post-emergence treatment 8 lbs per acre controls all grasses, and 8-16 lbs per acre controls approximately 50% of weed population. Most effective as a grass-foliage treatment and should be applied when grasses are well developed and growing vigorously. Thoroughly wetting is essential for maximum effect. Use 30 to 50 lbs per acre. For control of both grasses and broad leaf weeds, add 1 to 2 gallons of weed killer. Mfd Dow (Radapon, Dowpon); United Heckathorn. Cost \$.09 per pound.

n. 2, 3, 5, 6-TBA, 2, 3, 5, 6-tetrachlorobenzoic acid. A growth regulator; absorbed by plants and translocated downward into soil, where roots of untreated plants absorb it, and translocate it upwards.



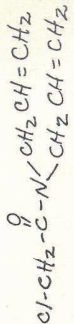
o. 2, 3, 6-TBA, 2, 3, 6-trichlorobenzoic acid. A growth regulator; absorbed and translocated downward through treated plants into surrounding soil where roots of untreated plants absorb it and translocate it upwards. Dimethylamine salt (2 lbs acid equivalent per gallon) is effective against broad leaf perennialials. Mfd Dupont (Tryben 200), Heyden, Hooker.



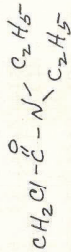
p. 2, 2, 3-TPA, 2, 2, 3-trichloropropionic acid, $\text{CH}_2\text{Cl}-\text{CHCl}_2-\text{COONa}$.

q. CDAA, 2-chloro-N, N-diallylacetamide, $\text{CH}_2\text{ClCON}(\text{CH}_2\text{CH}=\text{CH}_2)_2$. Selective pre-emergence herbicide. Four quarts per acre will control crabgrass, pigweed, and carpet

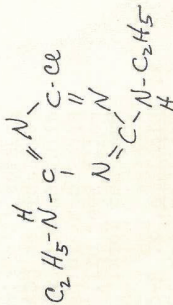
r. grass. Perennial weeds, such as nut grass, are not controlled nor are weeds larger than two-leaf stage. Mfd Monsanto (sodium salt) Cost \$10.10 per gallon.



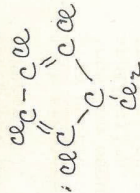
r. CDFA, 2-chloro-N, N-diethylacetamide, $\text{CH}_2\text{Cl}-\text{N}(\text{C}_2\text{H}_5)_2$. Controls grass weeds. Mfd Monsanto.



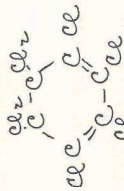
s. CDT, 2-chloro-4, 6-bis-(ethylamino)-S-triazine. Water soluble, 50% wettable powder, used for pre-emergence weed control in corn. Mfd Geigy (Simazin).



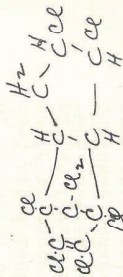
t. Hexachlorocyclotadiene, P-162. Has some contact herbicidal value as an additive to oils. Has given control of broad leaf weeds and grass in lawns. Applied following planting and rolling at rate of 1 cup to 5 gallons water plus emulsifier per 1000 sq. ft.



u. OCH, Octochlorocyclohexenone, Ck-tone, Strong, contact weed killer. Rapid action, causes water-soaked appearance within half-hour on most seedlings. Not affected by weather. Used as additive to oils; water emulsifiable form available in small quantity. Dry powder to be dissolved in oil at rate of 1 lb per 15 gallons No. 2 Diesel fuel or 12 gallons kerosene.



v. Chlordane, 1,2,4,5,6,7,8,8-octachloro-3a, 4,7,7a-tetrahydro-4,7-methanonon or 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanonindene or 1,2,4,5,7,7,8,8-octachloro-3a, 4,7,7a-tetrahydroindans-4, 7-methano or

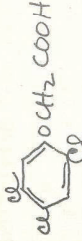


satisfactory when plants are growing rapidly and soil moisture is high. Under these conditions give superior results. Are water soluble and have low volatility. Salts ionize readily in aqueous solution and when sprayed on plant surface, stay there. Are most effective of 2, 4-D formulations for killing trees by cut-surface method. On Guam, the dimethylamine salt as a killer of tangantangan is effective at a concentration of 200 ml. per 1000 sq. ft. Mfd by Diamond Blackleaf Co. (2,4-D amine weed killer, dimethylamine salt, acid equiv 4 lbs per gal), Dow (2-4 Dow Weed Killer, Formula 40, alkanolamine salt, acid equiv 4 lbs per gal) at \$3.24 per gallon. American Chemical Co. (Weedar 64, alkanolamine salt, acid equiv 4 lbs per gal), and Swift (Gold Bear Brand 40 Amine Weed Control, isopropyl and diisopropanol amine salt, acid equiv 4 lbs per gal).

- (3) Acid formulations emulsifiable in water are available. Where drift and volatility are hazards they may be best choice. Metallic or inorganic salts ionize readily in aqueous solutions, are less volatile and less phytoxic.
- (4) Formulations of 2,4-D and 2,4,5-T mixed are called "Brush Killers". 2,4-D is much cheaper than 2,4,5-T. The latter is particularly useful for increased penetration when oil is used in the spray mixture. The mixture generally consists of 3/4 lb of the chemical plus 1/3 teaspoonful of emulsifier per gallon water. Thorough coverage is essential. Retreatment is usually necessary. A mixture containing 100 ml. each of the tetrahydrofurfuryl esters of 2,4-D and 2,4,5-T was an effective tangantangan killer on Guam, per 1000 sq. ft., although coconut palms and lemonchina were unaffected. The addition of TCA is said to increase herbicide effectiveness. Mfd Swift (Gold Bear Brand Woody Plant Control, butoxyethoxy propanol ester of 2,4-D and 2,4,5-T, acid equiv 1-1/3 lb per gal 2,4-D and 2/3 lb per gal 2,4,5-T); Swift (Gold Bear Brand 2-2 Brush Kill, butoxyethoxy propanol ester of 2,4-D and 2,4,5-T); American Chemical Paint Co. (Weedone

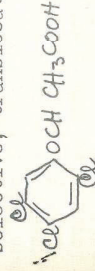
Brush Killer 32); American Chemical Paint Co. (Weedone Improved, butoxyethanol ester of 2,4-D and 2,4,5-T); and Dow (Esteron Brush Killer) at \$6.81 per gallon; also Ortho Brush Killer at \$2.20 per quart.

- b. 2,4,5-T, 2,4,5-trichlorophenoxy acetic acid. A selective brush killer. Ester formulations are most effective for translocation and assimilation. Insoluble in water, soluble in oil, used as an emulsion. Low volatility, high molecular weight esters most toxic.



Amine salts are less herbicidal, are soluble in water, and are more difficult to manufacture. Sodium salts are least effective herbicidally, and are water soluble. The tetrahydrofuryl ester is an effective tangantangan killer at 150 ml per 1000 sq. ft. Mfg. California Spray Chemical (estericide T 5, Low Volatile Brush Killer, tetrahydrofuryl ester of 2,4,5-T, acid equiv 4 lbs per gal); Swift (Gold Bear Brand 55 Brush Kill, butoxyethoxy propanol ester of 2,4,5-T, acid equiv 4 lbs per gal); American Chemical Paint Co. (Weedone 2,4,5-T butoxyethanol ester of 2,4,5-T); and Dow (Esteron 245) at \$9.18 per gallon.

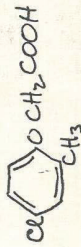
- c. Silvex, 2-(2,4,5-trichlorophenoxy) propionic acid. A selective, translocated herbicide for brush control.



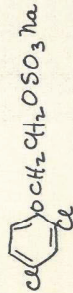
Low volatile ether esters, then amines, as with 2,4-D, are most effective herbicides. Several formulations such as amine salt, butyl ester, propylene glycol butyl ether (Propon 4). Primarily for brush control, may be effective against herbaceous weeds. Has longer residual effect in soil than 2,4-D. Is more effective against clovers, other legumes and chickweed than 2,4-D. Spray woody growth up to 6 to 8 feet tall after foliage is fully developed, using a spray containing 3 to 4 quarts of Silvex per 100 gals of water. Spray should drench all plant parts including leaves and stems. Avoid drift because of danger to other plants. For knapsack application of Silvex mix 1/2 cup full in 3 gallons water. Wet all foliage thoroughly. Do not apply to stoloniferous grasses in

established turf such as Bermuda, Zoysia and St. Augustine. Because of greater residual effect of this compound in the soil, it may inhibit root formation from the stolons of the creeping types of grasses over a longer period than 2,4-D. For broad leaf grasses and legumes use at rate of 1 1/4 quarts in 25 to 40 gallons of water per acre. Mfd Dow (Kuron, 2-(2,4,5-trichlorophenoxy) propionic acid, Propylene glycol (C₃H₆O to C₉H₁₈O₃) Butyl Ether esters, 64.5%).

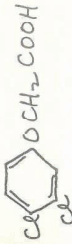
d. MCPA, MCP, 2 methyl-4 chlorophenoxyacetic acid. A selective, translocated herbicide for weed control. Herbicidal properties resemble 2,4-D although there are some specific varietal susceptibilities. Derivatives resemble corresponding compounds 2,4-D herbicidally, etc. Free acid insoluble in water, sodium and amine salts are soluble in water. Esters are oil soluble. MCP controls weeds in cereal crops such as oats, underseeded with legumes. Less injurious to clover and alfalfa in these underseedings than 2,4-D. Hurts ornamental bulbs in pre-emergence application as amine salt. Mfg Monsanto, American Chemical Paint Co. (Weedar MCP).



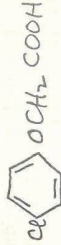
e. Sesone, SES, Sodium 2-(2,4-dichlorophenoxy) ethyl sulfate. Pre-emergence treatment for small seeded weeds, both broad-leaved and grasses. Injurious to many crops. Apply every 3 to 4 weeks for crabgrass control in turf. It can be used without danger for cultivated plants known to be extremely susceptible to 2,4-D. Non-phyto-toxic to plants, but toxic to germinating seedlings. Not active when sprayed, but converted to weed killer by soil microorganisms. Thus is effective only at sub-surface levels in cultivated soils. Controls approximately 50% of grasses, 10% of weeds as a pre-emergence spray. As post-emergence spray on bulbs, 4 lbs per acre results in no damage. Water soluble. Apply 2 to 4 lbs per 40 gal water per acre. Mfd Carbide and Carbon Chemicals (Sesone, Crag #1), cost \$4.50 per pound.



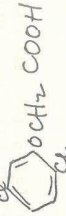
f. 3,4-DA, 3,4-dichlorophenoxyacetic acid. Selective, translocated herbicide, selectively effective against various weeds.



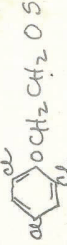
g. 4-CPA, 4-chlorophenoxyacetic acid. Selective translocated herbicide. Growth regulator.



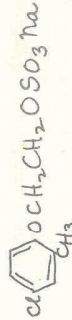
h. 2,5-D, 2,5-dichlorophenoxyacetic acid.



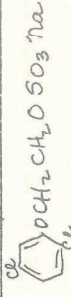
i. 2,4,5-TMS, 2,4,5-trichlorophenoxyethyl sulfate. Pre-emergence herbicide. Will control most annual broadleaf and grass weeds by killing seeds as they sprout. It will not control perennial weeds or established annual weeds. Apply 2 to 4 lbs per acre, using water as solvent. Mfd by Carbide and Carbon Chemicals (Natrín).



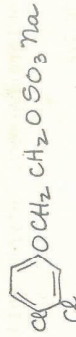
j. MCPES, 2 methyl 4 chlorophenoxy ethyl sulfate.



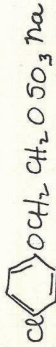
k. Sodium 2,5-dichlorophenoxy ethyl sulfate.



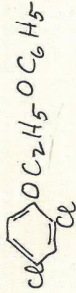
l. Sodium 3,4-dichlorophenoxy ethyl sulfate.



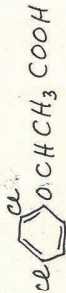
m. Parasin, sodium chlorophenoxy ethyl sulfate.



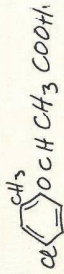
n. 2,4-DEB. Sesin, 2,4-dichlorophenoxy ethyl benzoate. Microfine wettable powder, for control of germinating seedlings of small seeded grass and broad-leaved weeds, shows promise in controlling crabgrass in turf.



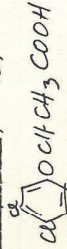
o. 2-(2,4-DP), 2-(2,4-dichlorophenoxy) propionic acid. For brush control. Mfd Carbide and Carbon Chemicals (2-(2,4-DP), butoxyethanol ester of)



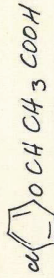
p. 2-MCPP, 2-(2-methyl-4-chlorophenoxy) propionic acid.



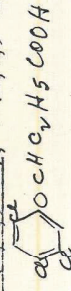
q. 2-(3,4-DE), 2-(3,4-dichlorophenoxy) propionic acid.



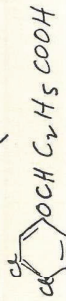
r. 2-(4-CPP), 2-(4-chlorophenoxy) propionic acid.



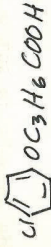
s. 4-(2,4,5-TB), 4-(2,4,5-trichlorophenoxy) butyric acid.



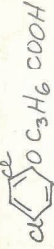
t. 4-(3,4-DB), 4-(3,4-dichlorophenoxy) butyric acid.



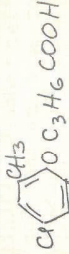
u. 4-(4-CPB), 4-(4-chlorophenoxy) butyric acid.



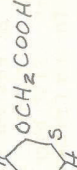
v. 4-(2,4-DB), 4-(2,4-dichlorophenoxy) butyric acid. For selective control of broad-leaf weeds. Mfd American Chemical Paint Co., Carbide and Carbon Chemicals.



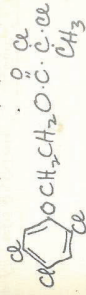
w. 4-(MCPB), 4-(2-methyl-4-chlorophenoxy) butyric acid. For selective control of weeds in legumes. Mfd. American Chemical Paint Company.



x. BOA, benzothiazol-2-oxyacetic acid.

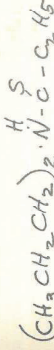


y. Erbon, 2-(2,4,5-trichlorophenoxy) ethyl-2, 2-dichloropropionate. Erbon is a non-selective herbicide for controlling both grasses and broadleaf weeds. It acts by both root and leaf absorption, and has a high degree of persistence in the soil. Effective in controlling Bermuda grass and pig weed. Nut grass and milkweed are not affected. Erbon forms an emulsion with water, and can be applied with fuel oil or diesel oil rather than water. Use 3 to 4 quarts of Erbon per thousand square feet, or 30 to 40 gallons per acre. Thoroughly cover all vegetation and exposed soil. Avoid drift into adjacent vegetation. Mfd by Dow (Baron).



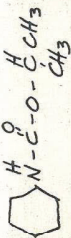
11. Carbamates

a. EPIC, Ethyl-N-N-di-n-propyl thiocarbamate. Pre-emergence herbicide for grass and broadleaf weeds. Weed control due to downward movement in soil, effective any



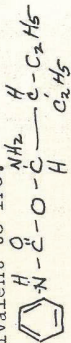
time prior to emergence. On Guam, applied as a post-emergence herbicide, use 2 to 8 lbs of aqueous spray per liter. Mfg Stauffer.

b. IPC, IPPC, INPC, isopropyl carbanilate, isopropyl-N-phenyl carbamate. Soluble in tributyl phosphate. Sl.

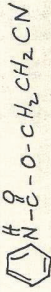


Soluble in water (100 ppm) is a mitotic poison which acts to prevent cell division. Not effective as a foliage spray, but acts through the soil. It is applied in the emulsifiable form and incorporated to a depth of 3 to 4 inches by disk or similar process. Planting follows promptly. 4 to 6 lbs per acre are used for the control of plants of the grass family (Graminaceae). It is relatively non-toxic to broadleaf plants. It is usually applied to soil as a pre-emergence treatment and it has found considerable use in the control of Bermuda grass (Cynodon dactylon). Effectiveness depends on soil moisture. Cost \$.80 per pound. Mfg. by United Chemicals Co. IPC, "Propham"; Pittsburgh Plate Glass Co.; and Cal Spray Chemical (Ortho Crabgrass Killer), at \$1.83 per quart.

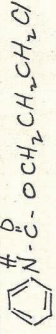
c. 2-Diethylaminoethyl-N-phenyl carbamate. Herbicidally equivalent to IPC.



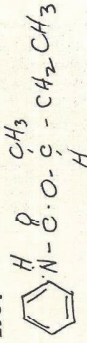
d. 3-Cyanoethyl-N-phenyl carbamate. Herbicidally equivalent to IPC.



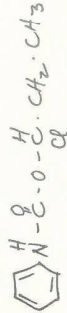
e. 3-Chloroethyl-N-phenyl carbamate. Herbicidally equivalent to IPC.



f. Sec-butyl-N-phenyl carbamate. Herbicidally equivalent to IPC.



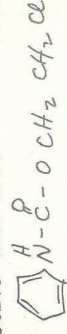
g. 2-(1-chloroethyl)-N-phenyl carbamate. Herbicidally more active than IPC.



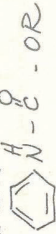
h. 3-buteryl-N-phenyl carbamate. Herbicidally more active than IPC.



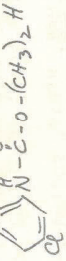
i. 2-chloroethyl-N-phenyl carbamate. Herbicidally more active than IPC.



j. Alkyl-N-phenyl carbamate. Herbicidally more active than IPC.

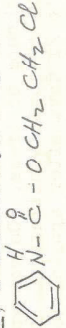


k. GIPC, O-isopropyl-N-(3-chlorophenyl) carbamate. Sl.



Soluble in water (80 ppm). Miscible in all proportions with short chain aliphatic alcohols. More soluble in organic solvents than IPC, more stable than IPC, persists longer in the soil than IPC. Pre-emergence herbicide for the control of most annual grasses in numerous perennial grasses. As post-emergence herbicide, killed broadleaf weeds but did not damage ornamental bulbs, 8 lbs per acre gives complete control of grasses; 8 to 16 lbs per acre 50% of weeds. Used at a concentration of 4%. Mfg Columbia Southern Chemical Corp. Cost \$2.62 per pound.

l. GEPCC, 2-chloroethyl-N-(3-chlorophenyl) carbamate.

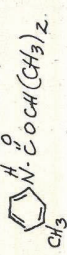


m. CPFC, 2-(1-chloroethyl)-N-(3-chlorophenyl) carbamate.

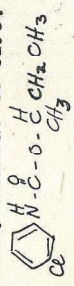


12. Urea derivatives

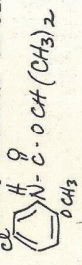
n. Isopropyl-N-(3-methyl phenyl carbamate. Herbicidally similar to CIPC.



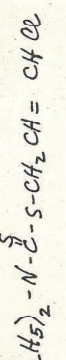
o. ECPC, Sec-butyl-N-(3-chlorophenyl) carbamate. Herbicidally similar to CIPC.



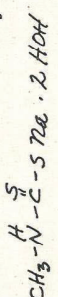
p. Isopropyl-N-(2-methoxy-5-chlorophenyl) carbamate. Herbicidally similar to CIPC.



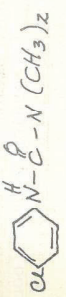
q. CDEC, 2-chloroallyl diethyl dithiocarbamate. A pre-emergence herbicide, selective for annual grasses and broad leaf weeds. Most effective in slight sandy soils. Apply at 6 lbs per acre rate in water solution. Highly effective for controlling crabgrass. Mfg. Monsanto (Vegadex) at \$11.62 per gallon.



r. SMDC, VAPAN, sodium-r-methyl dthiocarbamate dihydrate. Subsoil fumigant for eradication of weeds, germinating weed seeds, nematodes, fungi, soil borne insects, and soil sterilant. Kills grasses, broad leaf weeds, both annual and perennial, and their germinating seeds, such as nut grass, bermuda grass, water grass, and morning glory. Use 1 qt Vapan 4S per 100 sq. ft., applied with 10 gal water. Cost \$3.40 per gallon. Precautions: Do not apply within 3 feet of any living plant nor in dripline of large shrubs or trees. Do not apply in confined spaces without adequate ventilation. Do not plant sooner than 15 to 21 days after application. Mfg Stauffer (Vampan 4S) at \$3.35 per gallon; Chemical Insecticide Corp. (Chem Vape).



a. Monuron, CMU, Karmex W, Telvar W, C.80, 3-(p-chlorophenyl)-1, 1-dimethyl urea. Weed killer of soil sterilant type. Is not dangerous to animals or man.



80% wettable powder formulation which stays in suspension with agitation. Very slightly soluble in water (230 ppm). For pre-emergence spray use 4 lbs per acre. For destruction of all vegetation as a soil sterilant use 40 lbs per acre. Subsequent applications in lesser amounts may be necessary. Is effective by means of root absorption, more sensitive plants through absorption of lethal amounts through foliage. Monuron may be used throughout year providing it is moved to root zone by rainfall or artificial means. Best results are obtained if application occurs shortly before plant growth begins. It may be applied to dense weed growth provided sufficient water is used to carry chemicals to the soil, but better results are obtained if Monuron is applied when ground cover is at a minimum. Monuron must be fixed into soil by rainfall or water moving on the soil surface may carry the monuron laterally onto unsprayed locations.

In cases of prolonged exposure on soil surface, prior to being leached into soil by moisture, ultraviolet rays of sunlight slowly decompose monuron, destroying effectiveness.

Monuron is a stable product which resists moisture and oxidizing agents well, but is destroyed after a long period by soil micro-organisms. Prolonged product accumulation in the soil is negligible.

Oil, water, and monuron may be mixed and applied in one operation. Flocculation may be prevented in most cases by the addition of calcium caseinate conditioner at the rate of 1/2 lb per 100 gallons of emulsion. Monuron and conditioner should be thoroughly mixed with water prior to addition of oil. Breadfruit (*Artocarpus incanus*), Kamachile, and Eucalyptus are destroyed by Monuron. It has little effect on

pineapple, sugar cane, or established perennial weeds.

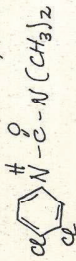
Where plants are resistant, spot treat with one pound monuron per five gallons of water, soaking the ground thoroughly. For suppression use foliar sprays of weed oil. Resistant plants are tangan-tangan, nut grass (*Cyperus rotundus*), morning glory (*Ipomoea congesta*), bermuda grass (*Cynodon dactylon*), and coconut palm.

Monuron provides better immediate results after application under low rainfall conditions, costs less, is more toxic to trees, and is less resistant to leaching than diuron.

Mfd Dupont (Karmex W, Telvar W) and Pechiney - Profil (C.80). Cost Telvar W (200-950 lbs) \$3.00 per lb (Tropical Garden Farms, Guam).

Used successfully on Naval Air Station, Agana, perimeter fence (20 lbs per acre in 400 gallon sprayer), internal security fence Andersen Air Force Base, and perimeter fence Naval Hospital, Guam. Is excellent grass killer, poor brush and tangan-tangan killer.

b. Diuron, DCMU, Karmex DW, Telvar DW, 3-(3,4-dichlorophenyl)-1, 1-dimethyl urea. Non-selective weed and brush killer, for most annual and perennial weeds on non-crop land such as utility, highway, pipeline rights of way, petroleum tank farms, lumber yards, storage areas, drainage ditches, etc.



Use diuron in situations where more than ten inches of rain has followed treatment before the dry season, rather than monuron. Diuron is unsatisfactory under low rainfall conditions, is less toxic to trees, and is more resistant to leaching than monuron. Bermuda grass is quite resistant to diuron. Apply 30 to 40 lbs per acre for initial spray, 10 to 15 lbs per acre for follow-up. Diuron reacts very much like monuron only where more moist conditions prevail. Diuron is approximately 1/6 as soluble in water as monuron, (40 ppm). The addition of additives can improve both control and cost. For control of broad leaf weeds,

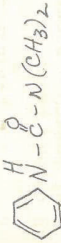
add 4 quarts of either 2,4-D amine or a mixture of 2,4-D and 2,4,5-T amine to the diuron spray, using lesser rates of the diuron. Follow up spot spraying of broad leaved weeds with hormone weed killers alone is usually advisable. Where 2,4-D ester or other oil formulation are used diuron, add 1/2 lb of calcium caseinate conditioner to each 100 gallons of spray.

Use of diuron plus aromatic weed oil (100 to 150 gal per acre without water dilution) is indicated where spraying must continue through rain and wherever quick top kill is important. In this combination spray add 1/2 lb of calcium caseinate conditioner to each 100 gallons of spray.

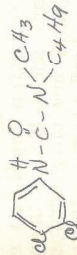
Where addition of 2,4-D or 2,4,5-T to diuron creates a spray drift hazard, add 200 lbs sodium chlorate-sodium borate to 300 lbs diuron in lieu of 2,4-D or 2,4,5-T, or Ammate X at 3/4 lb per gallon of water or weed oil.

Mfd Dupont (Telvar DW Karmex DW 80% wettable powder), (Telvar DL Karmex DL 28% liquid suspension), cost Telvar DW (200-950 lbs) \$3.70 per lb (Tropical Gardens Farm, Guam).

c. Fenuron, PDU, PMU, Karmex FW, 3-(phenyl)-1, 1-dimethyl urea. Soil sterilant and herbicide for brush control, deep rooted perennials in crop land. Application of 60 lbs per acre kills bermuda grass. Is more soluble in water (2900 ppm) than monuron, quicker acting and less permanent. Mfd Dupont (Karmex FW 80% wettable powder).

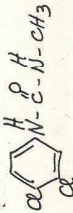


d. Neburon, 1-n-Butyl-3-(3,4-Dichlorophenyl)-1 methyl urea. Pre or post-emergence herbicide effective against crabgrass in turf. Useful where monuron or diuron can not be applied, because of a reduced tendency to leach downward in soil and a more limited foliage effect. Apply four pounds active ingredient per acre for control. Practically insoluble in water (4.8 ppm), sparingly soluble in

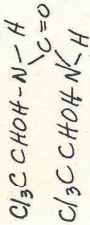


common hydrocarbon solvents. Water should be applied to soil after application of reburon. Mfd Dupont (Crabgrass and Chickweed preventer 18.5% wettable powder).

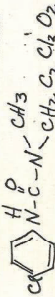
e. DPMU, Karmex M-1-W, 1-(3,4-dichlorophenyl)-3-methyl urea. Herbicide not as effective as monuron, diuron, or fenuron. Mfd Dupont (Karmex M-1-W).



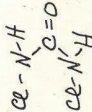
f. DCU, dichloral urea, 1,3-bis(2,2,2-trichloro-1-hydroxyethyl) urea. A pre-emergence herbicide, toxic to germinating grass seed. Has longer residual effect than IPC or TCA, effecting control as long as three months. May be applied as pre-emergence spray or disked into soil at rate of 14.6 lbs of active ingredient per acre. Mfd Carbide and Carbon Chemicals (Crag DCU 73 W is 73% wettable powder. Cost \$0.90 lb.



g. UROX, 3(p-chlorophenyl)-1, 1-dimethyl urea trichloroacetate. Mfd Gen Chem (22% wettable powder) Urox weed killer. For control annual and perennial grasses and broad leaf weeds in non-crop areas.



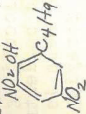
h. DH2, pre-emergence treatment for small seeded grasses in crops. Disked into soil shows promise of preplant grass weed control. Mfd Carbide and Carbon Chemicals (Crag herbicide no. 2)



13. Dinitros

Used for contact application. Action rapid and results evident after only a very short time. When applied in economical doses, they are only effective on weeds at the three- or four-leaf stage. If treated later, plant development is temporarily arrested, but is later resumed. Have a fairly high toxicity which increases with temperature, requiring care when handling such products.

a. DNBP, DNOSBP, 4,6-dinitro-0-sec-butyl phenol. Should not be used at temperatures above 85°F or during periods of high humidity or when plant growth is wet. Limited value for weed control in turf. Less selective than arsenicals and 2,4-D, and does not control as many kinds of turf weeds.



(1) Ammonium salt. Contains 1 lb DNBP per gallon. Water soluble, selective post-emergence herbicide for broad leaf weeds and grasses in legume crops. Apply 1 gal Am DNBP per 100 gal water per acre. "Sinox W" of Standard Agricultural Chemicals is 13% Am DNBP. Cost \$2.72 per gallon. "Dow Selective" is 13% Am DNBP at \$2.72 per gallon.

(2) Amine salt. Contains 3 lbs DNBP per gallon. Water soluble, pre-emergence herbicide with legumes, bulb and tuber crops. In post-emergence treatment acts like Am DNBP, but cheaper. Apply 1 gal DNBP per 80 gal water per acre. "Dow Pre-merge" is 53% alkamylamine salt of ethanol and isopropyl DNBP at \$4.72 per gallon. "Sinox P" of Standard Agricultural Chemicals is 57% triethanolamine and isopropanolamine salt of DNBP. Cost \$5.10 per gallon. "Elgetol-318" of Standard Agricultural Chemicals is the 36% triethanolamine salt of DNBP, used as a dormant insecticide and fungicide.

(3) The parent phenol, DNOSBP is dissolved in an aromatic hydrocarbon solvent with an emulsifier, so that Commercial formulation can be extended with oil, water, or an oil-water combination. Formulations contain 5 to 5.87 pounds of DNBP per gallon, and are used as general contact weed killers along ditch banks, as pre-harvest drying agents for legumes and grasses. Apply 1 quart per 6 gal kerosene and water to make 50 gal spray per acre. "Sinox General" of Standard Agricultural Chemicals is a 50% butylphenol, 10% amyl phenol mixture. "Dow General" is a 55% DNBP at \$9.18 per gallon. "United General Weed Killer" of United-Heckethorn is a 55% DNBP.

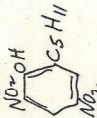
b. DNC, DNOC, 4,6-dinitro-0-cresol. Acts against broad

Leaf weeds and grasses. Not effective against legumes. According to the plants to be destroyed, 8-12 lb per acre is the usual dosage. Spraying is carried out at the rate of 100 gallons per acre. DNC is activated by addition of a small quantity of Ammonium Sulfate, as well as high temperatures. It decomposes fairly rapidly in the soil and there is therefore no risk of accumulation in the soil at low dosage rates. Can cause damage by leaching after rains into untreated areas. "Elgetol 30" of Standard Agricultural Chemicals is the 30% Sodium dinitro ortho cresylate used as a dormant insecticide and fungicide. "Sinox" of Standard Agricultural Chemicals is the 30% sodium dinitro ortho cresylate, used as a herbicide. Krenite-26 of Dupont is a 19% sodium dinitro ortho cresylate used as a fungicide.



c. DNP, ammonium dinitrophenate. Has same characteristics as DNC, but its effectiveness is greater. Dosage ranges from 2 to 4 lbs per acre. It is particularly useful for control of annual dicotyledons.

d. DNAP, DNOSAP, 4,6-dinitro-0-sec-amyI phenol. Contact herbicide and defoliant. DNAP has slightly lower phytotoxicity than DNEP. "Con-tax" is 75% DNAP of Standard Agricultural Chemicals.



14. Miscellaneous organic herbicides

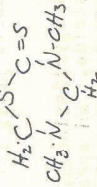
a. Carbon disulfide, carbon bisulfide, CS₂. Temporary soil sterilant. Apply by soil injection at 200 gal per acre.

b. NIX, sodium isopropyl xanthate, NaOCSCH (CH₃)₂. Contact spray. Selective for small weeds and grasses in vegetable crops, on hot dry, sunny days. Most effective when mixed with a heavy aromatic naptha, an emulsifier, and water. Water soluble powder. No effect on soil.

c. IPX, isopropyl xanthic acid weed herbicide.

d. MURPHOS, tributylphosphorothioite, cotton defoliant. Apply 1 pint per acre by ground or aerial spray. Mfd Virginia Carolina Chemical (Folex).

e. DMTT, 3,5-dimethyltetrahydro-1,3,5-2H-thiadiazine-2-thione. Soil sterilant for soil fungi, nematode and weed control. Apply by spraying as water suspension or spread dry 300 lbs per acre (1 lb per 50 ft²) evenly over ground surface. (Do not treat soil in areas closer than 4' to drip line of growing trees or shrubs). Mix into soil after application and irrigate with water. Wait 14-21 days after treatment before planting to avoid crop injury. Based on its molecular weight, mylone contains 17.3% nitrogen or 51.8 lbs of nitrogen when the product is used at the recommended rate of 300 lbs per acre. Although there have been repeated instances of stimulation when a crop is planted on soil treated with mylone, it is still to be determined how much of this increased growth is due to nitrogen and how much is the result of controlling soil pests. Crag (mylone) 85W is 85% wettable powder manufactured Carbide and Carbon Chemical.



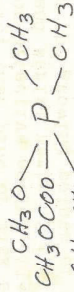
f. NPA, N-1-naphthylphthalic acid.

g. EXD, ethyl xanthogen disulfide.

h. EBEF, ethyl bis(2-ethylhexyl) phosphinate.

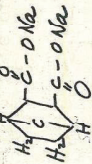
i. DIPA, P,P'-dibutyl-N,N-diisopropyl phosphinic amide.

j. Phosdrin, 2-carbomethoxy-1-methyl vinyl dimethyl phosphate. Mfd Shell (OS-2046).

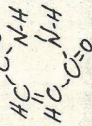


k. Endothal, 3,6-endohexa-hydrophthallic acid. A pre-emergence herbicide for weed control, defoliant and legume desiccant. Water soluble solid. Apply 6

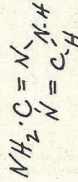
quarts endothal per 12 gal water per 3 oz activator per acre. Niagarathal-DF spray is manufactured by Niagara, costs \$2.90 per gal in 50 gallon drums. Penco endothal Harvest Air is manufactured by Penn Salt, costs \$2.25 per gal in 30 gallon drums.



1. MH, maleic hydrazide, 1,2-dihydropyridazine-3,6-dione. Plant growth inhibitor and herbicide. MH sprayed on plant surface is absorbed and moved internally to block the growth-promoting hormone present in plants. Plant reaction varies both with dosage applied and plant's stage of development. For control of quack grass, MH is transported in maximum quantities to the plants' rhizomes and in 4 to 8 days is plowed under. The sodium salt is more effective than the diethanolamine salt. 3% MH inhibits growth on *Dactyloctenium*, *Cynodon*, *Panicum*, *Paspalum*, and *Echinochloa*. A 2% solution discolors grasses. A 0.5% (5.56 lb per acre) solution showed least exterior characteristics. Apply 4 lbs per acre for grass control per 50 gal water. Mfd Naugatuck Chemical (MH-40 a 40% sodium salt at \$2.30 per lb, and MH 30% diethanolamine salt at \$6.00 per quart.)



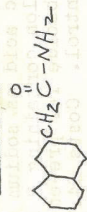
- m. Amitrol, ATA, AT, Amino triazole, Weedazol, 3-amino-1,2,4-triazole. Non-selective systemic herbicide for killing certain perennial weeds. Is a water soluble defoliant, not a soil sterilant. Apply directly to foliage of actively growing plants 8 lbs per 25 gal water per acre, then plow or disk several weeks after spraying for effective action. Is readily absorbed by the roots and aerial parts of the plant and will translocate to the growing points of plants in active growth, even young plants. Amitrol absorbed by roots moves upward in xylem, but when applied to the foliage is transported in the phloem. Amitrol affects plant by upsetting chlorophyll synthesis.



Weedazol is 50% amitrol of American Chemical Paint Co.,

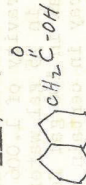
costs \$1.53 per lb. American Cyanamid manufactures A.T. (Aminotriazole) at \$2.63 per lb.

- n. NA amide, Naphthaleneacetamide.



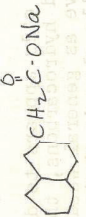
Growth regulator.

- o. NAA, Naphthaleneacetic acid.



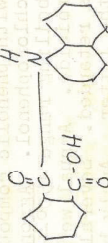
Growth regulator.

- p. SNA, Sodium naphthalene acetate.



Growth regulator.

- q. NPA, NP, Alanap, n-1-naphthyl phthalamic acid. Pre-emergence herbicide and growth regulator. Must be watered before NPA is effective. Bermuda grass is tolerant to treatment, water grass seeds eliminated.



(1) Alanap-1, a dry wettable powder containing 90% N-1 naphthyl phthalamic acid as active ingredient. Selective herbicide for annual broad leaf weeds and grasses. Apply at rate of 4 lbs per acre in 50 gal of water.

(2) Alanap-IF, a selective pre-emergence herbicide for crabgrass control in established lawns, 1% N-1 naphthyl phthalamic acid active ingredient.

(3) Alanap-2, a water insoluble 90% wettable powder containing N-1 naphthyl phthalamide as active ingredient. Has little soil mobility, is slower acting and has longer soil residual than other alanaps.

Apply at rate of 4 lbs per acre. Mfd Naugatuck, costs \$3.25 per lb.

(4) Alanap-3, a water soluble liquid containing 22% by weight N-1 naphthyl phthalamic acid as sodium salt. New 9.1 lbs per gallon; each gallon containing 2 lbs active alanap. Is selective herbicide for pre-emergence and post emergence weed control. Costs \$4.75 per gallon. Mfd Naugatuck.

r. Hydrin, mixture of aromatic hydrocarbons with boiling range of 260° to 340°C, specific gravity of 1.006 to 24°C. Contact spray of 5 to 7 gal in 75 gal water per acre for smaller weeds, 15 to 20 gal in 100 gal for larger weeds. Directed contact spray in certain crops, 5 to 15 gal in 75 gallons water. Pre-emergence applications in certain large seeded crops at 15 to 20 gallons per acre without water.

s. Petroleum oils, the toxicity of oils appears to depend upon the presence of unsaturated hydrocarbons, the heavy aromatics being most effective as general weed killers. They are characteristically slow in their action and, therefore, termed "chronic" weed killers. In the case of oils of low toxicity, the toxicity may be increased by "fortifying" with phenolic compounds such as the dinitros or pentachlorophenol. Agronol R, containing 40-50% aromatics (boiling range 450°-700°F) is a non-selective contact herbicide. Annual weeds and grasses killed, perennials retarded. Several applications necessary to kill the latter. Apply by spray at rate of 60 to 80 gal per acre at delivery rate 1.5 gal per minute at 50 lbs per square inch pressure. Agronol A, lower in aromatics, is less effective than Agronol R. Agronol A can be fortified with 30 pounds of pentachlorophenol per 75 gallons of Agronol A per acre for more effective use. Mobilisols 544B and 544C are effective herbicides but much more expensive than Agronol R. The lighter oil fractions in boiling range of 150°C to 275°C are used to control broad-leaved weeds. Stove oil and trade-name raphas, ordinarily used as paint thinners and for dry cleaning, Kerosene and light fuel oils are not effective herbicides.

The warm and humid conditions which prevail in tropical

Guam encourage luxuriant growth of weeds and brush. Many herbicides at concentrations used in the temperate zone with good results are not applicable in the tropics because of continuous rapid growth, leaching of herbicides from soil, more rapid breakdown of herbicides as result of higher temperatures and greater microbiological action. Factors which determine choice of herbicide include cost, effectiveness, selectivity, and ease of mixing and spraying. Data on herbicide activity on Guam is limited to the summary herein. It would appear that Chloro IPC, Monuron, and Na PCP have potential as turf killers, mixtures of 2,4-D, 2,4,5-T, TCA, NapOP and diesel oil, ammonium sulfamate and amino triazole as brush killers; and MCP Amine, Sodium Arsenite, and 2,4-D as selective weed killers in turf.

