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Western Society of Weed Science

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Presidential Address — Truth Is Our Business

Arnold P. Appleby[1]

It has always seemed to me that the Presidential Address might involve two aspects. First, it includes the *responsibility* to provide the membership with a sort of status report on the organization, a "State of the Society" mesage if you will. The second aspect perhaps involves a *privilege* of the President to present some personal opinions on the past, present, and future of weed science in general. These personal opinions certainly are worth no more than those of any other member but the program chairman has been kind enough to provide a few minutes on the platform and there are few of us strong enough to resist the temptation to pontificate and expound some of our views.

First, how is WSWS doing? This depends largely on what you expect of it. The Western Society of Weed Science is small; it is the smallest of all the regional conferences in the United States and, furthermore, it is not growing rapidly. This fact is of concern to some people. After all, we have become accustomed to associating success with expansion, great whirlwinds of activity, and trauma. But I must confess that I am not too concerned with our lack of growth. Perhaps the maintenance of quality and the successful carrying out of our objectives is fully as important as an increase in numbers. The Western Weed Control Conference, now the Western Society of Weed Science, was established principally for professional weed workers in connection with Western problems. The Weed Science Society of America is doing an excellent job of setting up study groups, carrying out public relations activity, of providing for presentation and publication of fundamental research of a national and international nature, etc. Most of us in WSWS are also members of WSSA and we support these activities wholeheartedly. I see no reason why our regional organization should try to compete in many of these activities with our national organization. I admire and respect other large societies with more members and more money, but I do not envy them. In my view, WSWS is serving a valuable function that is not being served by any other organization and at the present time we are a healthy and viable Society.

At a more specific level, we are constantly striving to improve procedures and activities in the WSWS. For example, an *ad hoc* committee has been working to improve our publications. The research progress report has continued to be highly useful to many of us and we believe that the efforts of this committee will lead to an even more useful exchange of information.

The program this year reflects an increased interest in teaching and training. A steady supply of well-trained graduates in weed science is to the interest and benefit of all of us whether we be industry, research, extension, or regulatory. Hopefully this trend toward increased interest in teaching will continue in future programs and activities.

Now let's take a brief look at weed science in general. There are many success stories in weed science over the past years, and there are many needs and problems remaining. No well-informed person seriously questions the fact that herbicides and other advanced weed control methods have contributed a great deal to improved agricultural technology. However, all is not sweetness and light in the weed science field. Many needs and problems still exist that will require the best efforts from all of us. More and more demands are being placed on fewer and fewer resources at a majority of our universities. Industry is asked to provide sufficient data to meet requirements which are not even clearly spelled out in many cases. Extension personnel are called upon to make recommendations at a time when registrations and clearances seem to change almost daily. Concerned and sincere but ignorant citizens often interfere with the very objectives that they themselves would support if they had complete understanding of the situation. Many improvements need to be made, many changes are required. We must have registration requirements more clearly spelled out. Herbicide manufacturers must be able to make crucial decisions earlier in the life of questionable products. Neither companies nor consumers can afford the inefficiency of repeated annual requests for still further information on a particular product, when in fact, all of that information could have been collected simultaneously had the requirements been clearly identified. We must have better communication between EPA and persons making recommendations. Specific information for the use of herbicides in non-cropland, in water, and for homeowner use is difficult to keep up to date.

All of these needs have been identified before and I shall not belabor them further here. However, there is one area that is seldom discussed at length which I would like to direct your attention to for a few minutes. My major concern since the appearance of Silent Spring and the ensuing controversy has not been that we would lose all of our pesticides. It has not even been that registration of pesticides would become more difficult and that costs would increase, although that certainly has happened. Rather, it has been that credibility of scientists and professionals in general has suffered considerably during the 1960's. We have heard social scientists, biochemists, laboratory physiologists, etc., who apparently have suddenly been blessed with a great blinding flash of brilliance and have become expert ecologists and pesticide technologists. We have

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squirmed uncomfortably or roared in outrage when these self-styled experts made the newspapers by abstracting some bit of toxicological data and extrapolating it to the entire ecosystem. Half-truths or incomplete information is sometimes as devastating as blatant lies. I have been told that a prominent scientist speaking out against 2,4,5-T used these very techniques. He allegedly showed colored slides of a youngster who had been exposed to brush recently sprayed with 2,4,5-T. Unquestionably, the child was suffering from an extreme skin disorder following this exposure. All of this was true and it certainly could make a convincing case against the use of this "dangerous poison." What he neglected to point out was that the brush sprayed with 2,4,5-T was poison ivy and the symptoms of the child were those of poison ivy toxicity. The Globe, Arizona hoax is another example of twisted and false information. In my view, persons who deliberately present false information to support their emotional feelings should be exposed to the public for the charlatans that they are.

However, our own record is not that clean either. Just as there are the emotional opponents of any use of pesticides, there are also those who hysterically deny that pesticides have ever caused any detriment to anyone. In my view, these people have been equally as damaging to agriculture, to the pesticide industry, and to society in general as those who campaign against pesticides. There is no longer any question that chlorinated hydrocarbons can build up in the food chain and can cause detrimental effects to some components of the environment. There is no question that some pesticides are highly toxic to humans and have caused injury and death to innocent persons. Nor is there any question that unthinking users of pesticides occasionally have ignored ecological principles in making pesticide treatments which has resulted in a greater pest problem than the original one. To close our eyes to these facts and to deny them categorically is simply telling the public that we cannot be trusted to tell the truth. Our defense against malicious charges should be *facts*, not vehement charges of our own.

I believe that decisions involving pesticides, as with all other introductions into our environment, should be based on a careful examination of the risk/benefit ratio. Part of our responsibility as professional weed workers is to provide information on both of these aspects, honestly and frankly. If an examination of the facts dictates against the use of a particular pesticide, then we should be the first ones to say so. However, we all know that in many cases, the risks are blown all out of reasonable proportion and the benefits are not adequately explained. There are many benefits to society of using pesticides. The commonly cited ones are that the farmers must have pesticides to make an adequate living or that pesticides allow more efficient food production which keep the cost of food down and help us feed more people in the world. All of these are quite true and important benefits. But often overlooked are other advantages to society. If pesticides were eliminated, we could perhaps still feed most of our people albeit at much higher food prices, but then many people are willing to pay higher prices to eliminate risks. To produce this food, however, much more land would be required. We could no longer afford the luxury of parks, of natural game preserves, of wilderness areas, of green-belts, and recreational areas. Most likely, all things considered, our total environment might deteriorate if pesticides were eliminated. These are the types of benefits which must be told and must be considered in future decisions.

My plea then to all weed workers everywhere is to provide unvarnished, unbiased facts upon which to base fair and knowledgeable decisions. If we are not placed in the position of "defending" any particular method, then perhaps one day, our testimony will be accepted without question.

I should say that I am optimistic about some aspects of the pesticide situation. Certainly some regulations are becoming very stringent, sometimes almost unreasonable. But I am pleased that more people now seem to recognize some of the benefits as well as the drawbacks of agricultural chemicals at the same time that pesticide defenders are starting to admit that risks may also be involved. This is a healthy sign.

One other point. All the stringent regulations on registration of herbicides and all of the sincere effort on the part of weed control workers to produce materials for the effective control of weeds will not be enough unless the users of these materials are well informed and conscientious. Recent actions against mercury fungicides as seed treatment materials can provide a powerful example of this point. A family in New Mexico was severely poisoned with mercury, apparently from livestock which had been fed treated seed. The subsequent cancellation of these fungicides and the following published reason for the cancellation can stand as a reminder to all of us: "Directions for proper use and caution statements in labels of the product have failed to prevent its misuse as a livestock feed".

I am confident that the Western Society of Weed Science will continue to thrive and that its members will continue to provide straight-forward, honest information about weed control practices. In the long run, the truth is what will serve society best.

The Continuing Evolution of Professional Weed Science Societies in North America

R. P. Upchurch, President
Weed Science Society of America[1]

Reflection on past and projected developments in the discipline of Weed Science allows us to draw some conclusions and to speculate on the nature of of our profession. With respect to regional weed science organizations in North America I propose for your consideration that they have now reached a stage of youthful maturity. The youngest, the Southern Weed Science Society (SWSS), has just celebrated its twenty-fifth anniversary and the oldest, the Western Society of Weed Science (WSWS), is entering its thirty-fifth year of existence.

All four of the U. S. regionals hold annual meetings and publish a proceedings on the papers presented and a separate research report on experimental work. They all have committees dealing with important interests based largely on regional aspects. In addition to these common features each of the regional organizations has some uniqueness. The Northeastern Weed Science Society (NEWSS) is distinctive in making its proceedings available at the meeting and providing a supplement at a later date. It has been experimenting with a computer produced research report and has now decided to generate a more comprehensive document on the response of plants to experimental herbicides using computer techniques. The SWSS has an outstanding student presentation contest. A research report is published on the basis of recommended practices, promising practices, and new practices evaluated for various projects within each state. It has recently published a manual on research methods in Weed Science.

The North Central Weed Control Conference (NCWCC) prepares a research report in which brief descriptions of individual research projects are reported and also summarized by a project leader. A similar procedure is followed in the WSWS. The Canadian regional meetings are sponsored by the National Weed Committee of Canada and sectional meetings are held in the east and west.

Although the regional organizations have had some financial problems in the past, they are now on a sound basis and appear to have learned how to generate the funds required to secure their future. The Weed Science Profession is blessed with these strong regional organizations. I know of no other agricultural profession which has such effective regional groups. The place of these groups in the future is assured. There is no doubt that the regional organizations will experiment with new techniques, projects, formats and programs. They will continue to document regional progress, problems and opportunities. They will grow in reputation, attendance and relevance as the years go by. While they will continue to provide a unique service to their respective regions their published works will have an ever increasing audience beyond the regional borders.

In summary, my impression is that the regional organizations are making and will continue to make an outstanding contribution to Weed Science. They are fully developed as to organization, continuity, and stability. In the future they will continue to occupy an orbit which is reasonably well defined and well appreciated by all concerned.

At the state and province level, professional weed science organizations are highly variable as to their nature. Without question, the California Weed Conference is the most well developed organization of this type. Many of the states do hold a two-day long annual pesticide school or the equivalent thereof where various professionals present information to an audience consisting mainly of dealers, distributors, and custom applicators. In Mississippi there is a state weed committee which is organized with 70 subcommittees to provide recommendations on weed control.

It is a fact that weed scientists in the various states tend to be located in diverse state, federal and private organizations and that the voice of the Weed Science profession needs to be heard more clearly at the state level. My personal view is that most states and provinces should be encouraged to have a professional weed science organization. Such organizations should be entirely independent of any specific organization. They should be constituted by those individuals who by their training and experience can be considered professionals in the area of Weed Science. Annual meetings should be held, officers should be elected, and statements should be issued in the interest of the profession. Such organizations could sponsor public meetings if they so desired. Certainly, they would provide a basis for closer cooperation among interested parties. Many precedents have already been set for this kind of organization and weed scientists should avail themselves of this avenue of involvement. Herein lies an opportunity heretofore uncultivated.

Recently I have reviewed the development of our national weed science organization. I have been amazed at the rapidity of progress in the national organization since its first meeting in New York City in 1956, just 16 years ago. We started with a professional magazine which had been on an irregular publication schedule and have now firmly established the journal *Weed Science* on a regular bimonthly schedule with a circulation of about 2700. The journal has been improved dramatically and is now edited by Dr. T. J. Sheets and four highly respected Associate Editors. Although

[1]Monsanto Company, St. Louis, Missouri 63166.

printing costs have soared over the years and this has been aggrevated by the increase in size of the journal, bold steps have been taken to keep the Society solvent.

In the beginning the Society met on an every other year basis. When annual meetings of the Weed Science Society of America (WSSA) were started in 1966 there was great concern that our profession could not support both regional and national annual meetings but these fears were unfounded as all of the organizations continue on a healthy basis. Although we have made great strides in our profession, my personal viewpoint is that we have been gathering strength and momentum for a great leap forward. In contrast to the regional organizations WSSA is undergoing a profound metamorphosis. This changing profile is not so obvious in a given six month period but in the future we will look back on the first half of the 1970's as a period of great development in WSSA. This evolution will take place not only because there is a great opportunity to be of service but also because it is absolutely essential for the health and perhaps survival of our profession.

Let us look at some of the problems we face. Man has a great need to make some rational decisions on how he can best use technology to maintain and improve our environment, and on how the world's population and supply of food, feed and fiber can be regulated so as to be in proper balance. Many of us in the Weed Science profession have a deep-seated conviction that we can make a significant contribution to mankind. Yet the minds of the people are being turned against us and our profession. It is unfortunate that some of the self-proclaimed experts on ecology are well meaning. Some of them even have technical training in specialized areas but it is obvious that they have foresaken the rudiments of the scientific approach. They even justify their irrational approach by saying that you have to overstate a case to get the attention of the public. Such individuals are doing a great disservice to mankind and to themselves by implying that herbicides are inherently bad and that they possess some sinister capacity to do harm. The real problem is that our national and local decision makers are acting in an atmosphere of panic. In this situation more and more unrealistic burdens are placed on those who are trying to contribute to the solution of problems, proper funds are withheld from research and extension workers and our resources and energies are squandered on items of little consequence. Meanwhile, problems of substantial magnitude remain unevaluated. One of the elements of great unfairness here is that the layman is led to believe that someone other than himself will have to bear the ultimate expense of every restrictive item of legislation and every wrong investment of the technology dollar.

It is difficult enough for our companions in Entomology, Agronomy, etc., to bear these burdens but at least they have mature national professional organizations and they have strong administrative voices at the state and province level. Not only is Weed Science lacking in these respects but it is my distinct impression that a strong administrative voice for Weed Science at the State and Province level will be established in the face of convert and sometimes overt objection of the existing administrative machinery at the departmental level. The creation of Weed Science departments in the agricultural universities is long overdue as is the increased support which the discipline merits. Yet the individual weed scientist is almost helpless to act on behalf of his profession less he be accused of lack of loyalty to his existing administration. Fortunately, the farmers and the weeds are our long term allies.

In the face of the above facts it is imperative that advances be made for our profession in those areas where advances are possible. Let us turn our energies and attention to the positive approach. WSSA initiated the popular magazine *Weeds Today* in 1970 and we are now in the third year of publication. We hope that four issues per year will be published on a regular basis henceforth and that this magazine will be an ever increasing means of telling a rational story about weeds and their control to the layman. We now distribute 50,000 copies per issue and if the combined program of raising support through advertising and subscriptions succeeds, distribution should increase rapidly. The future of *Weeds Today* will be assured only by having the support of a great many people. I cannot say too much for the men like Buchanan, Ahrens, Rodgers, Conterio, Andrews and others who have given over and beyond the call of duty to this project. I know of no other professional agricultural society which has undertaken such an ambitious and consequential project.

WSSA now has about 70 committees and subcommittees working on every conceivable aspect of weeds and related subjects. Over the years we have made excellent progress in the area of terminology and we are looking now to perfect this further and to work more closely with other organizations. We now have three major awards — Research, Teaching, Extension — and hope that all three of these will involve $1,000 or the equivalent thereof in 1973. In 1972 Ellery Knake won the Extension Award and Paul Santlemann won the Teaching Award. At the recent annual meeting, Boysie Day and Harold Minshall were elected as WSSA Fellows. In 1973 we look forward to the election of more Fellows and to the election of Honorary Members, individuals from outside our ranks who have made significant contributions in the interests of the weed science profession. In the publications area regular editions of the Herbicide Handbook and the Directory of Personnel Engaged in Weed Science continue to appear. The papers of the FAO sponsored International Weed Conference have now been published. We are starting a regular monograph series and the first edition will be out as early as twelve months form now. The first two titles for consideration are: "Surfactants and Herbicides" and "Weeds in the Aquatic Environment". Our PR Committee is the most effective of any national professional agricultural organization.

The WSSA membership now stands at about 1500 and in 1972 we will have a very vigorous drive to increase this. In addition we hope to develop an Associate Membership through which there can be interactions with dealers, custom applicators and other such individuals. In this manner the influence and benefits of our Society can be expanded greatly. In the PR area there will be a committee on getting articles into the public press, on publicizing our 1973 annual meeting and on evaluating the nature of articles which appear on weed science in the public press. A WSSA brochure and a logo are being developed to help us project our image. Dave Bayer is helping us to develop cooperatively with other organizations an Environmental Quality Directory.

In order to serve our members there are efforts on manpower placement, herbicide reference standards, computer programs, publications awareness, and on visual aids. The latter will embrace a photography contest, a photo bank and an effort on films and slide sets. Other committees are looking into losses due to weeds, the marijuana problem and the educational program.

Present plans are to initiate a WSSA newsletter in the near future in order that our membership might be well informed on developments in the weed world. To finance ourselves we have committees on endowment sales and displays. We even have a historical committee and a library and archives committee plus several others.

In the near future we hope that WSSA will join the Council on Agricultural Science and Technology (CAST). This organization will maintain a permanent staff designed to educate decision makers and others on various aspects of technology. CAST will not do the full job for our profession but it provides a significant opportunity for scientific agricultural organizations to act positively.

There are many more opportunities for the profession of Weed Science to develop. With all the legislation now requiring weed control jobs to be done perhaps we need to certify or register those who qualify as professional weed scientists less such a title be available to anyone who claims it. Perhaps we need to think about certifying those Universities having programs which meet reasonable standards for graduating Weed Scientists. Certainly there is a need for more cooperative efforts between related societies. I have already visited the American Society of Agronomy Headquarters for this purpose. There is an opportunity for closer working relationships between the regional weed science groups and WSSA. In some instances this cooperation needs to be formal as in the case of terminology matters. In other cases it is more a matter of individuals making a strong contribution on a particular committee assignment.

In my mind the next most significant milepost in WSSA history will be when we can afford a fulltime executive vice president and permanent headquarters location. At best this point is probably three years in the future. We have the equivalent of many full time workers now pursuing WSSA goals as a part of their normal work asignment. We will continue to need these parttime helpers on various committees and projects and I have made every effort in the last several months to involve more of the WSSA membership in committee work. But we still need a central office to help keep our programs coordinated and to provide continuity.

One of the greatest assets we have in WSSA is the adversity with which we are faced. This adversity provides an impetus for us to work together and a stimulus for us to achieve new accomplishments. The fruits of our profession are essential to society and the burden of convincing society that we have something to offer is upon us. The greatest professional challenge of my life has come with the honor of being the President of the Weed Science Society of America. I look forward to meeting this challenge on the basis of marshalling the dedicated contributions of Weed Scientists throughout the length and breadth of the land. Working together we will cause professional weed science societies in North America to continue their evolution.

Natural Occurring Toxic Agents In Plants and Their Relationship to Poisoning of Livestock and Congenital Malformations

Wayne Binns, D.V.M.[1]

Plants contain many chemical compounds, some of which are highly toxic to man and animals. These natural occurring toxic principles in plants may be briefly clasified as follows: Alkaloids, polypeptides, amines, glycosides (glucosides), oxalates, resinoids, minerals, and carcinogenic, teratogenic and photosensitizing agents.

The toxicity of a plant may be influenced by a number of factors that concern both plants and animals.

[1]U.S. Department of Agriculture, Agriculture Research Service, Poisonous Plant Research Lab. 1150 East 14th North, Logan, Utah 84321.

A. Plant Factors:

1. Toxic agents may vary greatly among plant species and varieties and among different parts of the plant. The toxicity may also vary according to the locality, environment, and stage of growth.
2. The toxic agents of many plants may be more concentrated in the roots, flowers, young leaves, or seeds. In some plants, all parts may be highly toxic. The leaves and seeds are invariably most poisonous to livestock since they are the parts most commonly ingested.
3. The chemical structure of the toxic agent may also differ according to the plant's environment. False hellebore (*Veratrum californicum*) and lupine species are examples.

B. Animal Factors:

1. Species of animals must be the first consideration. Plants that are definitely toxic to one species of animals may be harmless, under natural grazing conditions, to other species. Delphinium species (larkspur) commonly cause severe death losses in cattle, but sheep and horses are not affected.
2. Palatability of the plant and the amount eaten are always important animal factors for consideration in poisoning. Some poisonous plants are eaten in sufficient quantities to cause poisoning only by hungry animals or by thirsty animals immediately after drinking water.
3. State of health, level of each nutrient intake, age, sex, and stage of lactation are also factors.

There are a number of botanically unrelated plants that may induce the same syndrome of clinicopathological effects in the poisoned animals.

It is the common belief of many people that acute transitory illness and death are the only effects induced when poisonous plants are ingested by livestock. The fact is that some plants can cause clinical signs of poisoning that resemble many infectious and nutritional diseases, congenital anomalies, and cancerous-type growths.

The diagnosis of plant poisoning in animals is not a simple procedure. Blood tests and chemical analysis of the rumen contents are usually of little value. Frequently, information from many disciplines is necessary. Broad knowledge of plants and experience are required, which includes plant identification, knowledge of plants poisonous to animals, susceptible animals, lethal dose of the various plants, experience in making a range plant survey to determine the plants and amount grazed, and a knowledge of the clinical and pathological effects of poisonous plants on animals.

Too often in cases of livestock poisoning by plants, this information is not available and results in an incorrect diagnosis. Over the years, many incidences of livestock poisoning by plants have been improperly diagnosed and considerable money and time spent for the treatment of a specific disease which was not present.

It is estimated that 8 to 10 percent of the range-grazing livestock become affected by poisonous plants, in some manner, during the grazing season. In many instances livestock profit is inversely proportional to losses of poisoned animals. These losses are seldom caused by the man-made poisons, but are from the natural toxic substances present in poisonous plants.

Alkaloid producing plants:

Alkaloid producing plants characteristically induce acute toxic signs of the nervous system.

Cyanogentic plants:

Cyanogenetic plants [1, 2] may be defined as those that cause, under certain conditions, hydrocyanic (prussic) acid poisoning. Such plants are distributed throughout the plant kingdom in all parts of the world. They produce substances known as cyanogenetic glycosides during their growing stage. Such glycosides are not within themselves poisonous, but in the presence of certain enzymes they are hydrolysed and produce free hydrocyanic acid (HCN), which is highly toxic to both man and animals.

Hydrocyanic acid poisoning in grazing animals is directly related to three principle factors:

1. Amount of cyanogenetic glycoside and free hydrocyanic acid present in the plant at the time it is ingested.
2. Direct contact of cyanogenetic glycoside with appropriate enzymes or rumen microflora, which cause hydrolysis and liberate HCN.
3. Amount of the plant ingested, rapidity of HCN release and moisture content of the rumen.

There are several known, and probably many unknown, factors that influence the yield of cyanogenetic glycosides in plants. Some plant species or varieties within species normally contain high levels of cyanogenetic glycosides. In others, however, they occur only under certain conditions such as in sudangrass (*Sorghum vulgare* var, *sudanense*), arrowgrass (*Triglochin maritima*) and choke cherry (*Prunus virginiana*). Climatic conditions, soil factors, shade, and anything that retards plant growth and development may increase cyanogenetic glycosides in plants. In addition, such factors as wilting, frost injury, disease, parasites, and mechanical damage may cause a rapid increase in a plant that would otherwise have been nontoxic. In some plants, rapid regrowth after retardation favors the increase of glycoside.

The highest levels of HCN in plants usually occur in the early growth stage and decrease as the plants mature. Low soil moisture, high nitrogen and low phosphorous all favor HCN production; therefore, HCN producing plants grown on good soils are more likely to cause poisoning than those grown on the poorer type soils.

The plant itself seldom contains free HCN until the cyanogenetic glycosides have been hydrolized by the specific enzyme. If the glycoside and the enzyme occur in the same plant, free HCN may become present following such factors as bruising, cutting, eating, or other mechanical injury that releases the specific enzyme and allows it to unite with the cyanogenetic glucoside.

The chemical make-up of each glycoside varies and requires the action of a specific enzyme to produce HCN. The enzyme may be in the same plant as the cyanogenetic glycoside or in some completely different species.

It has also been shown by Coop and Blakley[3] that the rumen microflora may cause the release of HCN in cyanogenetic plants.

The HCN is rapidly excreted from the animal body without detrimental effects, unless the rate of absorption exceeds that of excretion. After this point is reached, the porphyrin enzyme cytochrome oxidase becomes inactivated which causes acute anoxia at the cellular level.

Hydrocyanic acid is rapidly absorbed from the digestive tract and eliminated through the lungs in exhaled air or detoxicated in the liver by conversion into thiocyanate and excreted through the kidneys.

Chronic HCN poisoning has been experimentally produced in monkeys and sheep, but there is no evidence to indicate it occurs in animals grazing range areas. [4, 5]

The minimum lethal dose of free hydrocyanic acid is approximately 2 to 2.3 mg per kg of body weight, depending on amount ingested.

Large amounts of HCN cause almost instantaneous death with spasms and respiratory failure. Smaller doses cause accelerated and deep respiration, irregular and weak pulse, bright red venous blood with bright red membranes of eyes, nose, and mouth that later become cyanotic. One may observe marked salivation, muscular twitching, irregular gait, dilation of pupils, bloating, convulsions, coma, and death from respiratory failure. The heart may continue to beat for a short time after respiration ceases.

The most prominent postmortem finding is the absence of lesions. In deaths from acute and peracute toxicosis, the venous blood may be bright red (cyanhemoglobin). In less acute toxicosis, the blood may be dark with general cyanosis. If necropsy is performed immediately, a distinct bitter almond odor may be detected in the gas from the rumen.

The clinical signs of poisoning are seldom seen as most HCN-poisoned animals die from acute or preacute poisoning. The affected or dead animals are frequently found soon after drinking water, which may account for the many dead animals found near their source of drinking water.

Photosensitization plants:[6]

Ingestion of certain plants causes animals to be abnormally sensitive to the direct rays of the sun and develop slight to severe inflammation of the skin. The areas of the body affected are those not protected by photodynamic pigments in the skin, hair, and wool. Photosensitization in animals is classed as primary and secondary types. In the primary type, certain specific plant pigments are not eliminated following ingestion. They are carried by the blood to the skin and causes the skin to lose its protective mechanism against the radiation in the ultra-violet rays from the sun. This causes a sun burning effect of the white area of the body. Examples of plants producing such pigments are: St. Johnswort (*Hypericum perforatum*), buckwheat (*Fagopyrum sagittatum*) and spring parsley (*Cymopterus watsonii*).

In the secondary types of photosensitization, the photodynamic pigment is phyllo-erythrin, a derivative of chlorophyll. In the healthy normal animal this pigment is readily eliminated from the animal following ingestion. In animals affected with certain liver dysfunctions, the phyllo-erythrin is not degraded or removed from the circulatory system and upon reaching the skin, interferes with the nonpigmented skin's protective mechansim against the radiation of the ultraviolet rays from the sun. Examples of plants causing secondary photosensitization are: Puncture vine (*Tribulus terrestris*) and littleleaf horsebrush (*Tetradymia glabrata*).

The general clinical signs of photosensitization in affected animals are: restlessness, marked erythema, and searching for shaded areas. Inflammation of the skin develops only on unpigmented or white areas. In cattle, the white areas become inflamed wherever they occur on the body, especially along the back and over the rib region. The skin of the udder, teats, escutcheons, and face are also frequently affected. In horses, the white markings of the lips, face, and lower portions of the legs are affected. In sheep, the muzzle, face, ears, back, udder, and female external genital organs show signs.

At the onset of the disease, the skin over affected areas develops acute erythema, subcutaneous edema, and eventually necrosis. In sheep, it may cause a marked enlargement of the entire head and ears commonly called "big head." The disease that is caused by little leaf horsebrush or coal oil brush (*Tetradymia glabrata*) on western ranges has resulted in deaths of many thousands of range sheep.

Postmortem lesions of photosensitization are confined to the skin in the primary type. In the secondary form of the disease, slight to severe liver necrosis will be present along with the skin lesions.

Plants containing teratogenic agents:

Maternal ingestion of false hellebore (*Vertatrum californicum*) on the 14th day of gestation has caused congenital malformations in lambs.[7, 8, 9, 10] The deformity has varied from a slight shortening of premaxilla to a marked distortion of all the bones of the head with fusion of the cerebral hemispheres, hydrocephalus with cyclopia, anophtalmia or microphtalmia. A proboscis-like protuberance usually arises from the median plane dorsal to the centrally located eye with a fibrous or cartilagenous core. Occasionally the deformity may involve full-term twin lambs in which one is normal and one deformed. In some cases the very severe gastrula-type deformities are associated with prolonged gestation in which the lambs remain alive and grow to excessive size. This may cause the prepublic tendon of the ewes to rupture from the excessive weight from the enlarged fetus and amnionic fluid. When such ewes are killed, the lambs are always severely malformed and alive. Occasionally a dead twin fetus is found undergoing maceration.

The teratogenic agents in *Veratrum californicum* have been characterized by Keeler.[11, 12, 13, 14, 15, 16] Three teratogenetic agents have been identified: cyclopamine (11-deoxojervine), cycloposine (3-glucosyl-11-deoxojervine), and jervine. All are teratogenic for cyclopian and related central nervous deformities caused by ingestion of *V. californicum* on 14th day of gestation.

The congenital deformity commonly called "crooked calf disease" has been induced by maternal feeding of *Lupinus caudatus* and *L. sericeus*. The poisonous agent causing this deformity has not been identified. The anomaly is characterized by arthrogryposis· scoliosis, torticollis and cleft palate.[17, 18, 19] One or all of these deformities may be present.

The maternal feeding of *Lupinus sericeus* from the 59th to the 100th day of gestation caused a marked torticollis with only a slight distortion of the right front leg. Cows fed *Lupinus caudatus* from the 40th to 70th day of gestation had marked arthrogryposis of both front legs.

Locoweeds have been reported by James *et al.*[20, 21] to produce congenital deformities that were long considered to result from selenium poisoning. The deformities have ranged from slight temporary to marked permanent flexing of the carpal and pastern joints.

Keeler and James[22] also showed a possible relationship between loco poisoning from *Astragalus* plants and lathyrism a poisoning of man and animal caused by ingestion of seeds of grass pea, Indian pea, green vetch (*Lathyrus sativus*) through the botanical relationship of the plants similarity of induced congenital deformities, and the chemical characteristics of the extracts obtained from loco plants. The preliminary assay of the locoweed plant extracts suggested the presence of aminoacetonitrile and β -diamino-butyric acid common in *Lathyrus sativus*.

Congenital deformities in the limbs of baby pigs have been inducerd by L. D. Edmonds, *et al*[23] through maternal feeding of poison hemlock (*Conium maculatum*). R. W. Menges, *et al.*[24] also found congenital deformities in pigs to be induced by the maternal ingestion of tobacco stalks (*Nicotiana tabacum*). The pregnant sows were allowed free access to the tobacco fields ofter the tobacco plant leaves had been harvested.

Plants containing cancer producing agents:

Bracken fern (*Pteridium aquilinum*) ingested by cattle in the curl stages of growth at subtoxic daily levels for 4 to 5 months has caused cancers in the bladder of cows.[25] Adenocarcinomas were experimentally induced in the intestines and lungs of rats when fed Bracken fern daily for 7 to 10 months.[26]

Cancers in the bladder of cows were first observed in Greece and resulted in a high mortality of the affected animals. This disease was improperly diagnosed for many years and called "red water" (Hemoglobinuria). The blood colored urine was caused from the hemangioma type cancer that had developed on the lining of the bladder from ingestion of bracken fern. Due to the scarcity of forage the cattle were forced to eat bracken fern which in many areas was the primary source of available feed for the grazing animals.

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Relationships of Range and Forest Management With Herbicides on Wildlife

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Introduction

Plant suppression materials, in the form of simple salts, have been used to control unwanted vegetation since several hundred years B.C. With the development of growth-regulating hormones in the late 1930's and early 1940's, herbicide use greatly accelerated and now represents one of the fastest growing segments of the pesticide industry. U.S. production of herbicides in 1961 exceeded 75 million pounds in 1966, it exceeded 220 million pounds, and from 1966-1969, pro-

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duction nearly doubled to 393 million pounds of synthetic organic herbicides and accounted for 36% of all pesticides produced in the United States. During the 5 years prior to 1969, herbicide production grew at a rate of 22% per year, and now represents a multimillion dollar product of the agro-chemical industry. The rapid growth in use of herbicides will probably continue in the years ahead, stimulated by special purpose types[5]. Epstein[3] proposed that by 1975 herbicides would comprise 60% of pesticide sales totaling 1.3 billion dollars.

Few realistic figures exist to describe the extent that herbicides are used. One survey, taken in 1965, shows 14.5 million acres were treated during that year[9]. This figure includes treatment of public and private rangelands, croplands, pastures, forest lands, aquatic sites, and lawns.

In the State of Colorado, nearly 600,000 acres of Federal lands are known to have been revegetated since 1936. Of this total, nearly 300,000 acres were treated with a chemical herbicide[16, 17, 18].

Effect on Animals

With the growing use of herbicide products on both private and public lands, land managers, environmentalists, and natural resource workers have become very concerned about the possible direct and indirect effect that these chemicals might have on humans, domestic animals, wildlife, and wildlife habitat. Questions asked concern the immediate and long-term health hazards to humans and other animals, and the effect of herbicides on the environment. Research during the past 20 years has revealed some answers to the question of how herbicides effect the environment and at the same time has raised others.

Toxicity

The question of toxicity is ever present. Having conducted an extensive review of the literature, House *et al.*[9] concluded that all of the herbicides listed in their report can be used for non-cropland vegetational control with little or no danger of direct toxicity to man or animals, and with one or two exceptions would not concentrate in the food chains. More recently Norris[20] determined the hazard of 2,4-D, 2,4,5-T, amitrol, and picloram and concluded that toxic field or chronic doses of these chemicals were very unlikely since the chemicals degrade within a few weeks.

Teratogenic Effects

A recent development associated with herbicide compounds is that of animal birth defects. Prior to 1963, testing of herbicides for teratogenic effects was not required by the Food and Drug Administration. In 1963 after the thalidomide problem arose, the President's Science Advisory Committee on the "Use of Pesticides" recommended that toxicity studies on pesticides include studies on the effects of reproduction on at least two species of warm-blooded animals through each of two generations.[23]

The Bionetics Research Laboratories of Bethesda, Maryland, under contract with the National Cancer Institute, tested various pesticides and related compounds for teratogenic effects. This testing program revealed that several esters of 2,4,5-T caused birth defects in laboratory animals. Further research by Dow Chemical and the Food and Drug administration revealed one of the causative factors was the presence of a chlorodioxin contaminant in the 2,4,5-T formulation.[3]

On April 15, 1970, the USDA suspended registration of 2,4,5-T for use on lakes, ponds, and ditchbanks. Also suspended were uses of liquid formulations around the home, recreation areas, and similar sites. On May 1, 1970, the U.S.D.A. issued a cancellation for use of all granular 2,4,5-T formulations for use around homes, recreational areas, and on crops intended for human consumption.[1]

Use of the chemical is still allowed on pasture, range, and forest lands, but only when the restrictions are complied with and when other available chemicals are not adequate for the job.

Environmental Effects

Water. — The presence of herbicides in our waterways is a matter of concern. Again the hazard seems to be minimized somewhat through the rapid degradation of many commonly used products. Norris[19] stated that the use of herbicides as monitored in western Oregon caused little threat to native fish populations in downstream waters. He reported that short-term damage had occurred in eastern Oregon where concentrations of herbicides exceeded 1,000 ppb. The presence of some herbicides in water cause a medicinal taste and odor, making it less palatable to some forms of life. Others can be toxic to fish, but studies have shown that where they can do so, fish often move out of the areas of concentration until sufficient dilution and settling have occurred to allow their reoccupation. Hirst and Bank,[8] reporting on the use of 2,4-D to control water vegetation in Tennessee, indicated that no acute effects were noted from the spraying of 20 to 100 pounds of 2,4-D per acre of water. The spraying did have an associated hazard in that the decaying vegetation affected the water's taste and color, and that the 2,4-D exceeded the .01 ppm concentration in the drinking water supplies recommended by the working group on pesticides, a Federal Interagency Committee.

Another problem with treated aquatic vegetation is that of eutrophication. The decay of large volumes of plant material resulting from herbicide spraying can so reduce the oxygen content of a lake or pond that the death of game and food fish follows.

Soil.—The persistence of herbicides in the soil depends on several factors. These include the chemical composition, rate of application, leaching characteristics and composition of the soil, and the acceptance of the compound by the soil. Persistence in the soil varies with the chemical used from a few days to several years. Where the vegetation depressing effects persist for long periods, food loss to wildlife is sustained and the habitat remains unsuitable for their occupation.

Vegetation.—Though research has not shown direct toxic effects of herbicides to wildlife, it should be remembered that the interaction of wildlife species to their habitat is complex. Through its use in brush or weed control, every herbicide has a potential of exerting major secondary effects on wildlife through ecological change.

One example of animal dependence on plants has been used as a rodent control method. Keith *et al.*[12], Tietjen *et al.*[22] in Colorado, and Hull,[10] in Idaho, found that rangelands treated with 2,4-D reduced Northern pocket gophers (*Thomomys talpoides*) by 80 to 94%. The killing of broad-leaved plants on the study areas so reduced the quantity and quality of food available to the pocket gophers that they were unable to survive. Johnson and Hansen,[11] studying the effects of 2,4-D spraying on western rangelands, found that pocket gophers and Least chipmunk (*Eutamias minimus*) populations were reduced by spraying, while montane mole (*Microtus montanus*) populations increased as a result of the increased grass abundance.

Wildlife

Wildlife exists only in combination with its habitat. Yeager[25] states that nearly one-half of the 369 mammal species, and over half (58%) of the 714 bird species indigenous to North America, are associated with woody cover. In some instances, an interrelationship exists between animal species and their habitat that cannot be changed without loss of the species. Sage grouse (*Centrocercus urophasianus*) provide such an example. Throughout the winter months, over 90% of the food intake by these birds consists of sagebrush (*Artemisia* spp.). They depend on the brush for cover and for nest sites. Sagebrush is also an essential part of the brood habitat, particularly in early and late brood stages. An interspersion of sagebrush densities, from scattered to dense, are utilized by broods throughout the summer months.[13, 21, 24]

Some of my own research in south central Wyoming has shown that some of the less conspicuous bird species might also be affected by sagebrush spraying. In this study brewers sparrow (*Spizella breweri*) populations were compared on sprayed and unsprayed sites of sagebrush. On the unsprayed sites, these birds were relatively abundant. Sampling in this area revealed a population of about 288 birds per square mile, while on the sprayed sites the population was much lower with only 45 birds per square mile.

Forest Management

The practice of timber stand improvement was recently discussed by Farrar and Brunett.[4] The current trend toward pure pine stands and even-age management, though economically desirable, is beginning to adversely affect wildlife on 8 of the 16 million forested acres in Louisiana.

Timber stand improvements accelerate the successional stages of forest lands. Hardwoods and brush are greatly reduced by mechanical and chemical treatments that change indigenous food or cover available for wildlife in the treated areas. When first treated, the modified timber stands can be beneficial to wildlife. The deadening of hardwoods and removal of decadent timber causes root sprouting and allows grass and shrub cover to thrive. This in turn can temporarily improve food and cover availability for game and nongame bird and mammal species. After about 8 years, the newly planted pines will overtop the hardwood cover converting the area to a barren forest floor not suitable for many animal species. Goodrum *et al.*[6], commenting on the loss of oak (*Quercus* spp.) stands through timber stand improvement practices, recommended that select high-mast producing white and black oak trees be left in the new stands to provide food for the many species dependent on this crop.

Beneficial Effects

Herbicides can be a useful tool to the game manager. They are relatively inexpensive, safe in their application, and selective in their kill. In some aquatic environments, they can be used to create small openings for waterfowl and they can be used to open areas for greater recreational use.

Early studies by Biswell *et al.*[2], Hamilton and Buckholtz[7], and Krefting *et al.*[14, 15] report beneficial effects to wildlife through the creation of brush clearings, the preparation of food patches, and the creation of deer browse. Biswell *et al.*[2] found that benefits accured to such species as cottontail rabbits (*Sylvilagus bachmani*), snowshoe hare (*Lepus americanus*) ruffed grouse (*Bonasa umbellus*) black tail deer (*Odocoileus hemionus columbianus*) Mountain quail (*Oreortyx picta*), Valley quail (*Lophortyx californicus*), and Mourning doves (*Zenaidura macroura*) through the creation of edge and production of diverse foods.

Biswell *et al.*[2] working in the chamise (*Adenostoma fasciculatum*) brushlands on the north coast region of California found that deer populations were higher in areas where the brush had been opened through brush treatment programs. He reported that the open brushland supported 40 to 110 deer per square mile and produced 115 to 140 fawns per 100 does. In the dense heavy brush, the deer populations were found to be 10 to 30 deer per square mile with fawn crops of only 60 to 85 fawns per 100 does.

Hamilton and Buckholtz[7] conducted experiments in Wisconsin to determine whether herbicides could be used in the establishment of wildlife food patches. Herbicides in this case were used to delay weed competition with the food crops. They concluded that it was feasible to eliminate post-planting tillage needs in the food patches when a pre-emergence spray was used and at the same time, produce a crop having a high yield and a good weedy ground cover that provided food and cover for the upland game birds.

Krefting and Hansen[14] and Krefting *et al.*[15] reported on studies in Minnesota where preferred browse production for white tail deer (*Odocoileus virginianus*) was increased through application of 2,4-D. Study plots of woody plants common to the upland forests of northern Minnesota were sprayed. Aspen (*Populus tremuloides*)· Jack pine (*Pinus banksiana*), oak and upland brush type vegetation were treated. Stem counts of highly preferred browse species such as chokecherry (*Prunus* spp.) dogwoods (*Cornus* spp.), bur oak (*Quercus macrocarpa*)· and Juneberry (*Amelanchier spp.*) increased on the sprayed plots in each type. Medium preference browse species such as prairie willow (*Salix humilis*) and prairie rose (*Rosa* sp.), increased on three of four plots and low preference browse species such as hazel (*Corylus* spp.), snowberry (*Symphoricarpos* spp.), blackberry (*Rubus pensilvanicus*)· remain mixed in abundance some increasing while others decreased. They found that deer use on the treated areas was 3 to 4 times greater than on the unsprayed plots, and this was attributed to the availability of preferred browse plants.

Conclusion

Herbicides have many uses that benefit wildlife, but it will be remembered that as with any pesticide tool, the herbicidal swords have two edges; one to benefit, the other can harm. To derive the benefit from herbicide use, land managers must work within the multiple use concept and consider wildlife, both game and nongame, when planning vegetal control programs. Without such planning, vegetal control practices can require an adaptation by a species beyond its capability, thus resulting in its ultimate loss within the treated area.

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Effects of Herbicides on Honey Bees[1]

Howard L. Morton and Joseph O. Moffett[2]

Herbicides have been often implicated in death losses of honey bees (*Apis mellifera* L.). A review of the pertinent literature suggests that most herbicides are relatively low in toxicity to honey bees (1); however, DNOC, sodium fluoride, and various arsenical compounds have caused high mortality of honey bees (2). The methods of evaluating toxicity of herbicides to honey bees has varied considerably. Bees have been dusted, sprayed, immersed and fed herbicides, and the method seemed to markedly influence the results. We evaluated several herbicides for their effects on honey bees when fed in 60% sucrose syrup for their effects after spray treatment in cages, and when applied aerially in the field.

Herbicides found to be relatively nontoxic to newly emerged worker honey bees when fed in 60% sucrose syrup at concentrations of 10, 100, and 1000 parts per million active ingredient by weight (ppmw) were: 2,4-D, 2,4,5-T, silvex, 2,4-DB, dicamba, 2,3,6-TBA, chloramben, picloram, EPTC, and dalapon (6). Bromoxynil and endothall were toxic only at 1000 ppmw. Paraquat, MAA, MSMA, DSMA, hexaflurate, and cacodylic acid were extremely toxic at 100 and 1000 ppmw when fed in 60% sucrose. Paraquat, MAA, and cacodylic acid were moderately toxic at 10 ppmw.

Various formulations and combinations of herbicides and carriers were sprayed on small cages containing adult worker honey bees (5). Toxicity was determined by making daily counts of dead bees for 14 days after treatment. MSMA, cacodylic acid, and paraquat were highly toxic. Diesel oil and a phytobland oil caused high mortality during the first 24 hours after treatment and very little the following days. Combinations of diesel oil-water and diesel oil-water-DMSO were less toxic than diesel oil alone but more toxic than water. Several formulations of 2,4-D, 2,4,5-T, silvex, picloram, endothall, and a 1:1 mixture of 2,4,5-T and picloram were not toxic when applied in a water carrier.

Picloram, 2,4-D, 2,4,5-T, silvex, 2,4-DB, 2,3,6-TBA, chloramben, dalapon, and EPTC were fed in 60% sucrose solution to honey bee colonies to determine their effects on brood production. Picloram, 2,3,6-TBA, and dicamba had no adverse effects on brood development at 1000 ppmw concentration. At 1000 ppmw, chloramben and dalapon caused a reduction in brood development, and 2,4-D, 2,4,5-T, silvex, 2,4-DB, and EPTC severely reduced or eliminated brood production. When phenoxy herbicides were fed at concentrations of 10 ppmw no adverse effect on any stage of brood development was observed, but at 100 ppmw amount of brood was reduced. Eggs did not hatch in colonies that were fed higher levels of phenoxy herbicides. The adverse effects of phenoxy herbicides on brood development were temporary and once the herbicides were removed brood development was resumed.

No 2,4-D or 2,4,5-T was found in honey sacs of the bees or in colonies sprayed by airplanes with these herbicides (4). The phenoxy herbicides usually kill flowers rapidly and flowers which are not immediately killed often wilt and there is an inhibition or blockage of nectar secretion (3). For this reason, it is unlikely that herbicides will be carried from plants to honey bee colonies. Herbicides are more likely to injure colonies by depriving them of their source of food by killing plants in the area of treatment and on which they forage for nectar and pollen than through direct effects as poisons.

[1]Cooperative investigations of the Plant Science and Entomology Research Divisions, Agricultural Research Service, U.S. Department of Agriculture, and the Arizona Agricultural Experiment Station.

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Subsurface Layering of Herbicides for Control of Weeds

A. Lange, H. Agamalian and H. Kempen[1]

The success of subsurface layering herbicides was demonstrated several years ago by Whooten and McWhorter (3). Working primarily in cotton they found that a small amount of EPTC could control weeds more effectively when layered in the soil than when mechanically incorporated. Following this work, EPTC and related compounds gave excellent nutsedge control in heavy clay soils of the Hawaiian islands,[2] however, selectivity to pineapple was reduced.

About this same time, Miller and Carter, working at the Shafter Cotton Research Field Station, showed low rates of trifluralin would control barnyard grass when the herbicide was applied by spray blade in a shallow layer below the surface of the soil.[3] Subsequently, Kempen has recently found that alachlor gave good control of yellow nutsedge when spray-layered.[4] However, this technique reduced selectivity to cotton.

About three years ago, Leonard, *et al.* (2) showed dichlobenil was more effective when spray-layered than when applied as granules for the control of field bindweed in a relatively high adsorptive soil. About a year later, Agamalian and Kempen demonstrated excellent field bindweed control by spray-layered trifluralin.[5] This work stimulated a series of uniform trials on the control of field bindweed from southern California to the northern Sacramento Valley (1). In all instances, trifluralin and a few related compounds gave long-term field bindweed control.

Much of the first field bindweed work with trifluralin was conducted in vineyards where field bindweed has become a severe problem in the non-cultivated vine row. By using two methods of layering herbicides, field bindweed has been controlled season-long with rates as low as 2 lb. per acre. The most effective method has been the layering of trifluralin by means of a spray blade mounted on a hydraulically operated French plow capable of moving in and out of vine row. This technique does not completely control the field bindweed at the base of the staked vine. The hydraulic operated blade was also accompanied on the tool bar by a straight blade, which sprayed a layer between the rows of vines thus giving control throughout the vineyard. With the exception of small infestations of field bindweed at the base of the vine which were later spot-treated with paraquat and 2,4-D, season-long weed control has resulted.

The second method used in vineyards utilized the French plow which pulls the soil from the base of the vine. Then trifluralin was sprayed in the bottom of the furrow, and on the shoulders and across the centers. The soil in the center was then tilled by a power driven tiller or disked. The trifluralin treated soil was subsequently thrown back to the vine row by an off-set disk. This left a layer of trifluralin treated soil at the bottom of the ditch, which acted as a barrier to the shoot growth of newly developing shoots of field bindweed. The technique also provided treated soil above the layer of trifluralin to take care of annual weeds and the small chopped field bindweed rhizomes occurring in the volume of treated soil. With this method, the base of the vine was not completely free of field bindweed and required subsequent spot treatment. In vigorous growing vineyards, the base of the vine (trunk) is often shaded rather quickly and usually required only a minimum spot treatment early in the season before the grape foliage shaded the base of the vines

The spray layering technique has been tested against johnsongrass and bermudagrass with somewhat less success than with field bindweed during the first year; but an appreciable stunting of perennial underground root and stem has been observed in the second year. Continuous retreatment of johnsongrass and bermudagrass infestations in vineyards and orchards is expected to give control.

Most of the trifluralin-related compounds, and a number of other herbicides have been tested using this technique. Of the compounds evaluated to date, CGA 10832, USB 3584, and A-820 have shown substantial activity. Those showing less effect on field bindweed

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[1]Agricultural Extension, University of California
[2]Unpublished data, A. Lange.
[3]Unpublished data, J. Miller and L. Carter.
[4]Unpublished data, H. Kempen.
[5]Unpublished data, H. Agamalian and H. Kempen.

included: nitralin, oryzalin, isopropalin, BAY 3591, and AN 56477. Chemicals other than trifluralin-related compounds showing activity included, dichlobenil and chloropropham. Those which showed a relatively small response on field bindweed were: R7465, MON 097, and SAN 9789.

At present, it appears that the most likely application of this new method will be for the control of perennial weeds in orchards and vineyards. However, some recent work has indicated that the layering of trifluralin in field bindweed-infested areas in annual crops may offer even greater potential use. Trifluralin resistant crops, i.e., safflower, cotton, carrots and beans will grow through some rates of trifluralin spray layered at 4-6 inches. Deeper placement may allow more crops to develop sufficient root systems for commercially acceptable yields. This placement may also allow roots to adequately penetrate the trifluralin layer. The root system of many of the monocotlyedonous crops and weeds are more susceptible to trifluralin than certain dicotyledonous plants. The roots of corn, milo, johnsongrass and bermudagrass are essentially stopped by a layer of trifluralin. The effectiveness of the layer of trifluralin appears to act primarily on the new growth or the apical meristems of the shoot of both field bindweed and dicotyledonous crops such as beets, cotton and melons.[1] The roots of some crops such as safflower, cotton and alfalfa appear to be better able to penetrate the barrier than crops and weeds of grass family.[1] The competitive effect of the trifluralin-resistant crops planted in weed-infested cropland will add appreciably to the control of perennials.

In conclusion, the prospects for the control of perennial weeds have been greatly enhanced by the development of the spray blade. Utilizing this technique with trifluralin along with the other tools now available, perennial weeds can be eliminated as a threat to productive agricultural land.

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[1]Unpublished data, A. Lange.

Industry and Extension Cooperative Grower Meetings

Stanley Heathman[1]

The successes and failures reported here of Industry and Extension Cooperative meetings pertains specifically to Arizona conditions. It is likely that some of our experiences can be utilized by others interested in meetings of this same kind. However, no inference is made that what has worked in Arizona, can be adapted in total for use in other areas. Local conditions and differences in personal, will always indicate the need for specific adaptation.

Some Reasons for Cooperative Meetings:

1. Both Industry and Extension have a need for reaching the grower with educational programs.
2. Both Industry and Extension have similar objectives, they want to encourage growers to use herbicides correctly.
3. The multiplicity of Extension and Industry meetings for grower's had become less successful with each passing year. There were just too many meetings and not enough facts.
4. It was reasoned that growers would attend a meeting if a broad area of information, dealing with specific weed problems was presented. They could listen to, and question all, of the "experts" at one time and draw their own conclusions.

Some Essential Elements Needed for Successful Cooperative Meetings:

1. The meeting should be concerned with one subject only and directed toward a particular audience.
2. The meeting should coincide with the time growers are planning this particular weed control program. They should be held in locations and environments convenient to the audience.
3. A lunch of excellent quality, furnished by Industry has been very helpful.
4. The meeting should last about 2 hours. Each speaker should have no more than 20 minutes to present his message.
5. Those companies representing the major suppliers of herbicides in a particular weed control area should be invited to participate. The Extension Specialist has had to make that decision.
6. The speaker should discuss the strengths and weaknesses of their own products. They should not discuss or pictorially represent the defficiencies of someone else's product.
7. The Extension or Research representative

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should be the last speaker on the program to assure that all points are adequately covered.

8. The question and answer period following the talks is often the most productive part of the meeting.

9. Desirable attendance by growers at the meeting is strongly dependent upon well planned advance publicity. County Agents and Local herbicide salesmen are the major influence in achieving grower turnout.

10. Industry representatives from the local area are much more desirable than someone showing slides of California walnut trees.

11. The meeting doesn't have to be on the same subject or in the same locations each year.

Some Successes and Failures:

1. Growers have indicated they like this type of meeting. The 6 yearly meetings on cotton weed control have brought out about 50% of the major cotton growers in the state.

2. The chemical salesmen, the men who work with growers every day, have attended at about a 90% rate.

3. Those who have participated in these meetings as a speaker, have probably received the best education. For example, the concept of herbicide combinations for control of weeds in cotton has become very well accepted by these Industry representatives.

4. Some chemical companies do not have as presentable a representative as other companies. It is best not to participate in the meetings if the representation is weak.

5. There may be a problem with free loaders attending these meetings. To date this has not been of serious concern.

6. There is always the problem of determining when these programs should be changed to different subjects or discontinued altogether.

7. Where Cooperative meetings have been held in subject matter areas where Industry and Extension have had less experience and information, they have been less successful.

Teaching Objectives In A Weed School at The County Level

Arthur H. Lange[1]

A weed school usually has at least two functions: (1) to act as a refresher course, and (2) to bring new information to the student.

The weed school student body in California is made up largely of technical sales personnel from chemical companies, commercial applicators, technical staff from large farmers, a few technically oriented small farmers, college students, state and county personnel, irrigation districts personnel, and others.

The weed course is usually tailored somewhat for the specific audience depending on their major interests. However, several general topics are usually utilized for purposes of refreshing the students.

The first of these is usually weed identification. This is a particularly difficult subject in a short term weed school. Major weed species are usually discussed with the aid of colored slides covering several stages of development of the weed. Often in the spring fresh material is used. More emphasis is needed on weed identification. It still remains the weakest area in weed control.

The second subject we can call the identification and familiarization with the herbicides. A brief discussion on the names of the herbicides, the label, the principle chemical and physical characteristics, and some of the biological and soil responses of the individual herbicides are covered. A review of the symptomology of important herbicide groups needs considerable repetition before the student learns the area. This is a subject deserving considerable emphasis in any weed school.

Calibration is an area that is often included in weed schools. Here a demonstration is usually more effective than a chalkboard-type of discussion. The 10 minute quiz can be most helpful in teaching the technique of calibrating spray equipment and calculating dosages.

The next area is the incorporation of herbicides. This subject should cover the mechanical means of incorporation as well as the importance of irrigation and rainfall. A related subject often added at this point is the effect of soil type, i.e., the emphasis on the significance of organic matter and clay content. This is usually accomplished by using a number of the common herbicides and soils as examples. Simple pot demonstrations are usually very effective.

Closely related to soil and herbicide activity is the residual characteristics of herbicides and the factors that influence herbicide residues in the soil.

With the general basic areas of weed control covered, the second half of the weed school usually includes selective weed control in crops of interest in the area where the weed school is being conducted. Here the herbicides currently registered and recommended and their problems are covered. In addition, the new herbicides showing promise are often touched on lightly to give the subject the positive slant since few crops have all their problems answered in the currently registered herbicides. Another area often neglected in weed schools is the integrated program approach of weed control which takes in all methods of weed con-

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trol particularly the cultural aspects of growing a specific crop. This, however, should be covered with the specific herbicide for a crop.

After selective control in crops have been discussed, specific weed problems of outstanding importance in the area are covered. These are often perennial weed problems such as johnsongrass, bindweed, nutsedge or bermudagrass in California.

Another subject often covered is non-crop weed control, emphasizing the necessity of keeping fence rows, ditch banks, etc. clean, often as these control measures relate to weed control in crops. This often is a good point on which to finish a weed school, since there are many more solutions to problems in non-crop areas than in crops. The many legal restrictions on the use of herbicides can often leave a weed school participant frustrated when only crops are discussed.

Other areas that can be covered in a weed school if the weed school extends over a several-week period is a more extensive review of plant anatomy and plant physiology particularly of the problem weeds. A basic knowledge of these areas can help in understanding the weed control problem.

With the extended-term weed school, covering several weeks, it is highly desirable to utilize the 10 minute quiz in order to stress certain points.

The Use of Discussion Leaders and Packets in Extension Weed Short Courses

Dean G. Swan[1]

Situation:

Personnel working with pesticides in Washington are required to pass a state department of agriculture written examination and acquire a license.

Coperative Extension personnel are to provide short courses for reviewing and teaching the subject matter included in the examinations.

The short courses could be held at a limited number of locations and be taught by the specialists.

Advantages

Personal contact
Flexibility in subject matter
Special equipment not necessary

Disadvantages

Student travel distance
Time consuming for specialist
Large audience

The short courses could be held at an unlimited number of locations using discussion leaders (county agents) and packets.

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Advantages

Short student travel distance
Efficient use of specialist's time
Convenient for students
Small audience

Disadvantages

No contact with specialist
Little flexibility in subject matter
Special equipment necessary

For the past two years the discussion leader- packet system has been used.

Objective:

To conduct short courses for personnel working with pesticides that will cover the subject matter included in the examinations.

Methods:

Provide a short course package including:

A. Notebook
   1. Discussion leaders outline including:
      Overview, Weed control, Insect control, Application, Pesticides, Laws, records, Appendix
   2. Weed control section includes:
      Why weeds are problems
      Methods of control
      Types of plants
      Growth habits
      Herbicides and mode of action
      Factors affecting control
   3. Pesticide section includes:
      Formulations
      Safety
      Label

B. Video tapes
   1. Video tapes are provided covering sections of the subject matter.
   2. Visual aids are used to advantage in the tapes.
   3. Tape sections are short (10-28 minutes, averaging about 15 minutes).
   4. Discussion leaders develop the subject matter between sections.
   5. Slide sets are provided for locations without video equipment.

C. Slide sets
   1. Sets of seedling and mature weed slides are provided with accompanying brief descriptions.
   2. Discussion leaders can select and use those appropriate to the local area.

D. Study guides and references
   1. Study guides and references are made available prior to the short courses.
E. Pest control handbook
   1. A 569 page handbook has been compiled by Washington State University and Washington State Department of Agriculture personnel.
   2. This book includes the fundamental principles of pest control and can be purchased by the student.

Evaluation:

The packet method has been used with success. There have been equipment problems. Moreover, it is important for the discussion leader to feel confident in the subject matter he is moderating and teaching. A detailed evaluation is now underway to be used as a guide in improving the short course teaching.

What a County Agent Expects From a Weed Specialist

Ralph A. Horne[1]

Weed control 1972: A year of ecologist, conservationist, and extremist. . . . A year when more and better methods of weed control are expected, yet at a time when greater controls and restrictions are being imposed. There is a demand for weed control to help improve farm production, cities and industry want safety and fire protection and greater weed control for beautification purposes. Health departments are wanting relief for suffers from allergies caused by pollen from weeds.

Never has the demand for a more comprehensive weed control program been greater yet at a time when the need is so great to protect our environment.

On a local level the Extension Agents are in a position to help with the weed control for greater efficienty of agriculture production, make recommendations to industries, cities, counties for general weed control and to work toward helping sufferers from allergies. However, with the broad areas covered by most Agents, it is imposible to research and seek out for oneself the answers so it is necessary that a state specialist provide much of the information and assist in the counties in some areas.

One of the most important functions expected of the weed specialist is to provide a complete and up-to-date control guide based on research applying to a particular area. Agents need to be supplied with information on uses of new chemicals, improved methods of uses of known chemicals, and possible new chemicals talked about in farm papers.

Information is desired on all methods of control, not just chemical. This means an awareness of cultural, biological, mechanical, as well as preventative methods of weed control.

In many counties or areas, there are particular problems identified only with that area and need special attention. The specialist should help on recommendations for control and help set up research design where necessary and help carry out on-site research. The specialist should be the contact with chemical companies and State Department of Agriculture.

Helping an Agent to set up demonstrations of new methods and materials has a two-fold purpose: to acquaint the Agent with the product or method and to use as a demonstration site for educating the farmers. Efforts of this type should be planned for in advance by a team effort of weed specialist, agronomist, Extension Agent, and in many cases, the landowner.

Special in-service training for Agents should be conducted, as well as holding training sessions for county weed committees, weed boards, weed supervisors and spray operators.

Mass media such as radio, television, magazines and newspapers are an important method of education to the general public. The specialist is in a good position to spread the good word on weed control using this method. State, regional, or county-wide meetings can and should be conducted by a state weed specialist. Often these are too general in nature. We should look at a particular problem and often work with a certain commodity group.

We should often center on a particular weed, a given area, and zero in on actual cost which is often the deciding factor, whether weed control or not.

A weed control specialist needs to be a walking herbarium able to identify all plants, or at least get them identified. Identification is the first step of control of weeds. An awareness to identification at any stage of growth is important. Knowing the plant, growth habit, common and scientific names are important to carry out programs listed above. He, the specialist, also should be an encyclopedia of botanical terms, a person so versed in knowledge to gain understanding from the researchers, yet a layman in nature, able to talk the language of farm folk.

Weeds, as you know, are a prime habitat for insects. Weed control is often one of the best methods of insect control. Extension Agents expect the weed specialist and entomologist to cooperate on control practices. An example of this is weeds that produce aphids, lygus bugs that cut alfalfa seed production.

Weed control on federal lands is a real problem. First, we are told their are no funds available; second,

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federal personnel are restricted as to what can be done to change the environment; third, state weed laws have no controls on federal land, and so what we have is a real problem that affects weed control in the Western United States. Weed specialists are looked at on a state-wide basis to work out ways and means to control certain weeds on federal lands. This requires planning at least one or two years in advance.

State-wide programs, working with state road departments, beautification, utilities, such as railroads, power and light companies, are all a must on a weed specialist's agenda.

As much as I hate to admit it, County Agents don't often have the time, needed desire, nor the ability to do all that we should toward weed control. So, again, the specialist has to change hats, drag out his psychiatrist couch, and bring about desire and a change of attitude in the Agent.

There are many other places where a specialist needs to fit in —

Proper chemical application.
Safety in handling.
Cultural practices.
Water weed control.
Source reduction for mosquito control
Land drainage.
Disposing of chemicals.
Environmental factors.
What to do with land after weed control.

Meeting the Educational Needs of Noncrop Clientele

W. B. McHenry[1]

The elusive noncrop or industrial weed control clientele is a large, immensely diverse group and poses a challenge in reaching them for both educators and herbicide sales personnel alike and likely to pesticide regulatory officials as well. The noncrop clientele associated with agriculture, beyond the farmers and ranchers themselves, such as irrigation districts are mainly reachable for we at least know where they are. Other groups such as state and highway maintenance and mosquito abatement personnel have for years been serviced by chemical companies, by county regulatory officials, and by county agricultural extension offices. Highway and railroad agencies have for perhaps 100 years been required to cope with vast acreages of weeds, and although there is no direct organizational channel of communication, we see them at state weed conferences and county weed meetings. For the most part, then, avenues of communication exist with agriculturally oriented (agricultural chemicals oriented) and highway and railroad noncrop clientele.

Noncrop farm and industrial weed control clientele requiring methods of abating undesirable wild vegetation including aquatic weeds:

Individuals

Farmers
Ranchers
Home owners

Businesses

Agricultural consultants
Agrichemical dealers, applicators
Housing enterprises (sub-division contractors, trailer parks)
Industrial plants (lumber, petroleum, electronic, metal fabrication, etc.)
Land appraisers
Landscape architects, maintenance
Loaning agencies
Nurserymen
Radio and TV
Recreation enterprises (private)

Utilities

Electricity transmission
Telephone
Railroads (including rapid transit)

Governmental agencies

Federal government (Army, Navy, Air Force, Bur. Rec., Bur. Land Mgt., Forest Ser., Soil Conservation Ser.
State government (dept. agr., fish and game, water resources, div. forestry, highways, health dept.
Local government (irrig. dists, rec. dists, flood control, mosquito abtement, roads, parks, agr., fire, airports, school districts, etc.

There is still another potpourri of companies, industries, and governmental agencies with vegetation control needs that we know are out there but for which there does not seem to be a readily recognized avenue of communication. These are the subdividers caught with undeveloped land due to high unemploy-

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ment or interest rates that deter potential home buyers, city fire or public works departments with the responsibility of weed abatement on unimproved private or municipal property, tax accessors, municipal and county airport managers, and many others. They are all faced annually with decisions on reducing or eliminating weeds usually for purposes of either fire protection or to preserve aesthetic values. The choice of herbicide may be made by someone in the main office, often the purchasing agent, who has little or no training or experience in plant science or agricultural chemicals. If the weed control is conducted by a commercial pest control operator, results will likely be satisfactory. If, on the other hand, an unqualified company or agency employee is temporarily relieved of his regular job duties to do the spraying, anything short of a satisfactory weed control operation can, and does, happen. All too often, the use of herbicides to resolve a given weed problem on noncrop sites is handled with little more planning or forethought than would be expected if the weeds were to be controlled with a hoe.

Meeting the educational needs of the far-flung noncrop clientele is a challenge that must somehow be met. Towards this end, California Agricultural Extension, for the first time in 1972, issued a separte weed control pamphlet titled "Non-Crop Farm, Industrial, and Aquatic Weed Control Recommendations." Here-tofor the University's noncrop recommendations were printed in a combined cropland and noncrop publication. On some occasions we know that the combined recommendations were discarded by such agencies as irrigation districts simply because they had opened it to "Alfalfa" or some other crop page and believed the pamphlet did not relate to their needs. The introductory section of the separte noncrop publication has been expanded and includes sections on warnings on the use of chemicals, regulations, spray drift, basic weed control methods (burning, mechanical, chemical), advantages and disadvantages of using herbicides, and a section on using the herbicide recommendations. Reading this introduction or just glancing at the subheadings should suggest to even a rank novice that there is somewhat more to weed control than buying the lowest priced herbicide around and having the grounds gardener or storehouse keeper apply it.

In 1971 a noncrop weed control training school was developed by California Agricultural Extension jointly with the California Department of Water Resources and the U.S. Bureau of Reclamation, Region 2, for canal right-of-way maintenance personnel. The 1.5 day school programs were developed in 5 parts: plant section, herbicide section, regulations, spray rig calibration, and the environment and weed control. A mimeographed manual (not available for general distribution) was developed for the schools; this will be revised and printed as a University of California publication in 1972.

It would seem that in time anyone using herbicides or other pesticides will have to be licensed. Increased regulation to save the environment is the trend. The California Agricultural Code was amended in October, 1971 (Senate Bill 1021), to require anyone making pesticide recommendations (county, state, Federal, and University employees exempted) to be licensed. This law also requires that all specific pest control recommendations for particular property or parts thereof be in writing (no exemptions). Some irrigation districts and other agencies have been considering devising an in-house certification of competence in weed control for their own employees. The noncrop weed control schools incorporated this idea by including a written examination. Given near the close of the 1.5 day sessions, these exams included ten questions covering each of the five basic units of the course.

Since this was an initial experience for most of the agency employees, it was decided to allow the participants to correct each other's exam. This proved to be a popular part of the program for them and served as a particularly effective teaching aid.

Next spring a similar course will be presented at four locations in the state for the mosquito abatement districts of which there are some 60 in California. Weed control for them means source reduction programs. The more difficult communication channels to other noncrop sectors remain to be developed but somehow, someway, we must address ourselves to reaching them.

Current Status of Federal Weed Legislation

J. F. Spears[1]

Over the past 10 years we have seen an increased interest by the State departments of agriculture, farm organizations, and others in the control and prevention of the spread of noxious weeds. The National Association of State Departments of Agriculture, at their 45th convention in 1963, adopted a resolution calling for a uniform State and Federal noxious weed law. Pursuant to this resolution, a committee was formed, and a model State weed law designed to establish uniform standards for the control and eradication of noxious weeds was drafted. At the annual meeting of NASDA in 1966, a resolution was passed urging the enactment of a Federal noxious weed control law and the establishment of a noxious weed control contingency fund in the U.S.

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Department of Agriculture to be maintained at $1.5 million annually. They further resolved that this fund be administered in a manner similar to the Plant Protection contingency fund.

In late 1967, an Interagency Ad Hoc Committee on Preventive Weed Control was appointed by the joint action of the Weed Control Committees of the U.S. Departments of Agriculture and Interior. The ad hoc committee included representatives of the Departments of Agriculture, Defense, Interior, and Health, Education, and Welfare.

The ad hoc committee had three primary objectives: (1) To assess the current status of preventive weed control technology, (2) to evaluate the adequacy of State and Federal legislative authority, and (3) to recommend research, education, and regulatory programs. An official report was submitted by the committee on June 3, 1968.

This report has been the basis for the initial attempts to get an effective weed prevention program off the ground.

Committee Recommendations

These recommendations include a suggestion that existing Federal legislation be amended to cover noxious weeds, weed seeds, and other propagating parts. Closely related to this are two recommendations for revising the Federal Seed Act regulations: First, to prohibit crop seed containing any weed seeds designated as noxious from being imported or from moving interstate and second, to lower the tolerance level of weed seed permitted in crop seed either to zero or to the lowest practical tolerance. Then there is need for a good detection system and a plan for prompt reporting. Early detection is the real key to the success of dealing with new introductions. When we became serious about halogeton in 1952, it already had spread to more than a million acres. Likewise, witchweed had probably spread to more than 30 countries before we started work on it in 1956.

It is felt that these recommendations have merit. As an alternate to amending existing legislation, however, a USDA committee has drafted a suggested Federal Noxious Weed Act that would be an entirely new piece of legislation. It would assure Federal-State cooperation in weed control programs. Also, it would give us a much greater degree of protection against incipient infestations of noxious weds that are newly introduced into the United States or infestations that have not heretofore been widely distributed within our borders. At the same time, the Act would help us to keep out noxious weeds that do not already occur in this country. Based on our limited experience with halogeton and witchweed, we know it is better to keep weeds out than to have to deal with them after they have become established.

To insure effective safeguards at ports-of-entry, personnel of Agricultural Quarantine Inspection of the Animal and Plant Health Service would be given authority to inspect and pass on imported equipment and materials that might harbor noxious weeds. Also, Plant Protection officials, either independently or in cooperation with the States would be authorized to control any domestic outbreak of newly introduced weeds. Finally, reductions would be made in presently allowed tolerance levels for the amount of weed seed permissible in crop seeds that are purchased by farmers.

One of the committee's recommendations has already resulted in a new law that provides for controlling noxious weeds on land under the jurisdiction of the Federal Government. This Act, Public Law 90-583, the Carlson-Foley Act, was passed by the Congress and signed by President Johnson on October 17, 1968. It provides the necessary authority and authorizes appropriations for effectively controlling noxious weeds on lands under the control of or jurisdiction of a Federal Department. The committee can take some credit for getting this legislation off from dead center.

Although the Carlson-Foley Act has been on the books over 3 years, funds have not been made available to the various Federal Departments for its implementation.

In 1971, Senator Clifford P. Hansen of Wyoming introduced an amendment to Public Law 90-583 which would make a single Agency in the U.S. Department of Agriculture responsible for administering the Act. Although no action was taken on this amendment in the last session of Congress, I understand that Senator Hansen's amendment will be scheduled in the hearings now being conducted by the House and Senate Agricultural Committees.

Present Status of Federal Legislation

As I indicated earlier, the committee has drafted a Federal Noxious Weed Act that would be an entirely new piece of legislation.

When consideration was first given to this legislation, it was thought that the Plant Protection and Quarantine Programs could be granted the necessary authority for noxious weed control by amending the Plant Pest and Organic Acts that now give the Secretary of Agriculture certain authority for the control and eradication of insect pests, plant diseases, and nematodes by adding the word "weeds." However, the committee soon ran into difficulties and, on the advice of the Office of General Counsel, USDA, the Federal Noxious Weed Act was drafted.

It is the purpose of this proposed legislation to give the Secretary of Agriculture the necessary authority to carry out operations or measures necessary to detect, eradicate, suppress, control, or prevent the spread of noxius weeds *new to or not theretofore widely preva-*

lent or distributed within and throughout the United States. The Act also authorizes the Secretary to cooperate with Mexico and Canada to control noxious weeds. It gives the Secretary authority to quarantine any State, territory, or district of the United States or foreign country, when necessary, to prevent the spread of noxious weeds. The Secretary may also promulgate regulations he deems necessary to prevent the introduction into or the dissemination within the United States of noxious weeds.

The proposed Federal Noxious Weed Act merely gives the Plant Protection and Quarantine Programs authority to deal with noxious weeds in the same manner that they now deal with *insect pests, plant diseases, and nematodes*. The Act does not give the Secretary of Agriculture authority to engage in general weed control of weeds already widely distributed in the United States.

A final copy of the proposed Federal Noxious Weed Act has been submitted to the Plant Industry Committee of the National Association of State Departments of Agriculture for their review. NASDA adopted a resolution supporting the Act in principle. The resolution asked for comments from the Weed Society of America, State regulatory officials, and the Association of Seed Control Officials. None of the organizations that have been asked to review this proposed Act has opposed the draft, and the comments received to date have not changed the substance or intent of the Act.

In considering any legislation concerning a regulatory program for noxious weeds, it is especially important that such a program be so designated that it would be both effective and enforceable. This proposed legislation is currently under consideration within the Department, and I trust that we will have some action on this proposal in the near future.

A Proposed Mechanism for Diuron-Induced Phytotoxicity

C. E. Stanger, and A. P. Appleby[1]

That diuron inhibits the Hill Reaction in photosynthesis is well known. However, this does not explain why diuron is essentially non-toxic in the dark and much more phytotoxic at high light intensity. Other researchers have speculated on the possibility of toxic secondary substances being formed in the plant as a result of Hill Reaction inhibition and light.

We studied the toxic action of diuron in isolated spinach chloroplasts. Toxicity was measured by the degradation of chlorophyll. Light was necessary for the expression of diuron toxicity. The addition of an artificial electron donor system (ascorbate plus 2,6-dichlorophenolindophenol or DPIP), which has been shown to supply electrons prior to non-cyclic photophosphorylation, completely prevented diuron toxicity. This donor system was effective only in functional chloroplasts, indicating that an intact system is necessary for the protective action.

Ascorbate + DPIP provided protection against diuron in the presence of methylamine HCl, an inhibitor of photophosphorylation, which suggests that a lack of ATP is not the cause of diuron toxicity. Kinetic studies showed that carotenoid pigments began to degrade more quickly than chlorophyll in the presence of diuron which tends to support Krinsky's proposal (Biochemistry of Chloroplasts, 1:423-430) that carotenoid pigments are functioning naturally to protect clorophyll from photo-oxidation.

Diuron toxicity was much greater when ratios of chlorophyll-to-diuron molecules were 200:1 or lower than at ratios of 300:1 to 800:1. These results support a previous conclusion that diuron acts at a photosynthetic reaction center comprised of approximately 250 chlorophyll molecules. These data also support a previous proposal that phytotoxicity from Hill-Reaction herbicides is directly related to chlorophyll concentration.

Diuron is a potent inhibitor of the Hill-Reaction, thus preventing the formation of NADPH. Experimental evidence gained in this study supports the hypothesis that specific carotenoid pigments function in the presence of NADPH to prevent photosensitized chlorophyll molecules from becoming potential oxidants. Our results, then, lead to the proposal that diuron induces phytotoxicity by limiting NADPH, thus catalyzing photosensitized oxidation reactions which are lethal to the cell.

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Irrigation Studies with Preemergence Herbicides

A. H. Lange and H. A. Agamalian[1]

The movement of preemergence herbicides with springler irrigation was studied under field conditions. Soil moisture at the time of herbicide application was important with volatile herbicides such as trifluralin and pebulate. Timing of sprinkler irrigation after herbicide application was important with volatile herbicides such as EPTC, trifluralin and R7465.

The quantity of water affected downward movement of mobile herbicides such as RH315 and terbacil. Quantity of water affected the downward movement of simazine, dichlobenil and trifluralin to a lesser extent than the more mobile herbicides.

[1]Extension Weed Specialist, University of California, Parlier and Salinas, Calif.

The persistence of volatile herbicides was directly related to the amount of herbicide moved into the soil by sprinkler irrigations.

The Influence of Temperature and Moisture on Tomato and Weed Responses to Trifluralin and Isopropalin[1]

J. LaMar Anderson[2]

Abstract: Tomato (*Lycopersicon esculentum* Mill. 'VF-99') seedlings were grown in trifluralin (a,a,a-trifluoro-2,6-dinitro-N, N-dipropyl-p-toluidine) treated soil under controlled temperature conditions. A temperature-herbicide dosage interaction was observed. Tomato seedlings were more sensitive to trifluralin at 13 C than at 18 C as measured by seedling dry weight. Similar temperature responses were observed with isopropalin (4-isopropyl-2,6-dinitro-N, N-di-(n-propyl) aniline) although tomato seedlings were more tolerant of isopropalin than trifluralin. Redroot pigweed (*Amaranthus retroflexus* L.), wild oat (*Avena fatua* L.), barnyard grass (*Echinochloa crusgalli* L.) and rye grass (*Lolium multiflorum* Lam.) seedlings were more susceptible to trifluralin and isopropalin at 18 C than at 13 C.

Introduction

The environmental conditions under which a plant is growing may modify the phytoxicity of an herbicide. Recently, humidity (4), soil moisture (1), temperature (1, 3, 6) and soil pH (2) have been shown to have a great influence on the success or failure of an herbicide. These factors affect the growth and growth rate of seedlings as do herbicides. The interaction between the herbicide and the environment may result in good weed control one year, poor weed control another year, and even injury to a normally tolerant crop a third year.

We have observed such differential responses of tomato seedlings to trifluralin. Usually under Northern Utah conditions, trifluralin at 0.5 lb/A (ai) controls most annual grasses and broadleaved weeds without injuring direct-seeded tomatoes. Occasionally however, such tomatoes have been severely stunted by this treatment. This study was initiated to determine what effect temperature may have on the response of tomato seedlings to trifluralin and the related chemical isopropalin during seedling germination and establishment. Observations also were made on the effects of soil moisture on seedling response to those herbicides.

[1]Approved as Utah State University Agricultural Experiment Station Journal Paper No. 1267.

[2]Plant Science Dept., Utah State University, Logan, Utah 84321.

Materials and Methods

Commercial preparations of trifluralin and isopropalin were obtained from Eli Lilly & Company. All herbicides were thoroughly mixed into the soil. In the field, chemicals were incorporated 2 inches deep by tilling twice with a rotary tiller with L-shaped blades immediately after treatment. In the laboratory, the herbicides were mixed into the soil in a rotary mixer for 1 hour prior to planting. A 1-ppm laboratory treatment was calculated to be comparable to a 1-lb/A field treatment on an acre 3-inch basis. Seeds of tomato, redroot pigweed, wild oat, barnyard grass, and ryegrass were directly seeded into the treated soil.

Tomatoes are known to be very sensitive to temperatures less than 10 C (5). The critical temperature for tomato seed germination is about 14 C (7). Seedling germination and emergence require much more time at soil temperatures of 12-13 C than at 14 C and higher. Seedlings were grown either in growth chambers or in plastic containers in a soil temperature tank at 13 or 18 C. In experiments where soil moisture was the variable, soil moisture levels were determined with Irrometers. Growth responses were measured by comparing the average dry weight of 25 seedlings per treatment to that of untreated seedlings. Treatments were replicated three times.

Results and Discussion

Tomatoes planted in trifluralin treated soil at ½ lb/A occasionally showed typical trifluralin injury. The seedlings were stunted and typical root pruning was observed. Tomato seedlings grown in soil treated with isopropalin (EL-179) showed no treatment response when grown at 13 C. When seedlings that exhibited an injury to the ½ lb rate of trifluralin were removed from the 13 C growth chamber and held at room temperature, they recovered from this injury and after 1 month were indistinguishable from the untreated seedlings grown under comparable conditions. This experiment was repeated six times. In two of the six, seedlings were stunted by trifluralin at 13 C. In the other experiments, no injury was detected. No injury was observed in any treatment at 18 C. The sporadic occurrence of injury might be because the tests were conducted near the threshold of a temperature-injury interaction. It was not practical to lower the temperature further because of excessive delays in tomato seed germination at temperatures lower than 13 C, hence comparative tests were run at higher herbicidal rates.

Seedlings were grown in trifluralin at rates of ½, ¾, and 1 lb/A under controlled temperatures for 11 days, and then removed to the greenhouse to allow recovery. When grown at 13 C, the threshold of injury occurred above ½ lb/A of trifluralin, whereas tomatoes grown at 18 C did not show injury until rates were above ¾ lb/A (Fig. 1). The dry weight of seedlings grown in ¾ lb/A trifluralin at 13 C and those grown in 1 lb/A at 18 C showed a 50 percent reduction after 28 days.

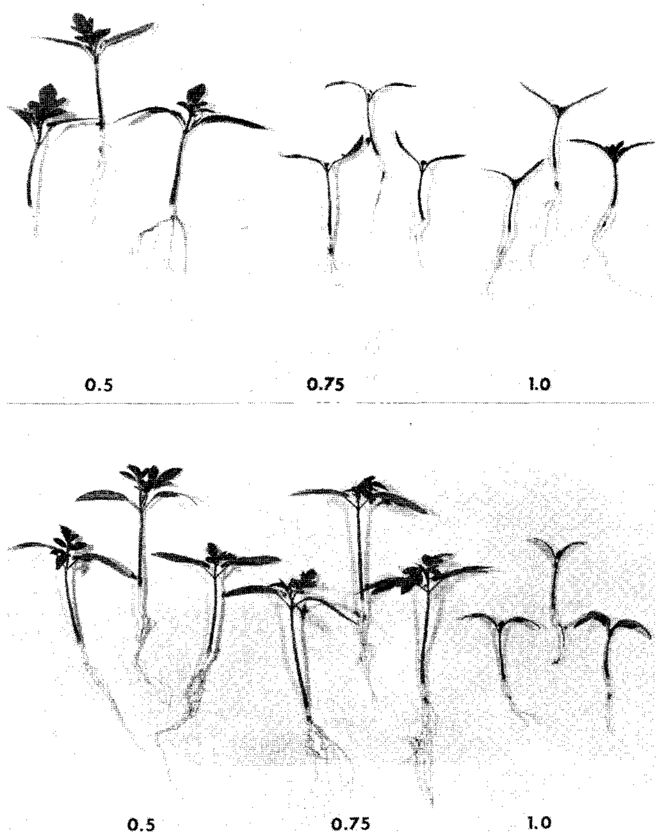

Figure 1. Tomato seedlings grown in soil treated with ½, ¾, or 1 ppm trifluralin showing temperature influence on growth. The ¾ ppm treatment was more phytotoxic at 13 C (above) than at 18 C (below).

Isopropalin appeared to have a much greater safety factor than trifluralin. Significant growth reduction at the 13 C temperature level did not occur until the 2 lb/A treatment (Table1).

To approximate field conditions more closely, additional experiments were conducted in soil temperature tanks. In these studies, soil temperature was kept at 13 or 18 C while the air temperature was 22 C. Seedlings were removed from the temperature tanks after 7, 10, and 14 days and placed at room temperature. Dry weights were taken after 28 days (Table 2). Similar trends were observed when seedlings were grown in soil temperature tanks as were observed in growth chambers; however, the reductions in seedling growth were not as severe at higher treatment levels as they were in the growth chamber.

Table 1. Temperature Effect on Tomato Seedling Response to Trifluralin and Isopropalin.

Treatment		13 C[a]	18 C[a]
Trifluralin	½ lb.	12.4[b]	18.4
Trifluralin	¾ lb.	6.9	19.3
Trifluralin	1 lb.	8.6	9.4
Isopropalin	1 lb.	19.4	....
Isopropalin	1½ lb.	20.3	....
Isopropalin	2 lb.	5.5	....

[a]After 11 days in growth chamber, tomatoes were moved to 22 C greenhouse

[b]Average dry weight (mg) after 28 days

Table 2. Soil Temperature Effect on Tomato Seedling Response to Trifluralin and Isopropalin.

Treatment		13 C[a]			18 C[a]		
		7 days	10 days	14 days	7 days	10 days	14 days
Trifluralin	½ lb.	32.9	22.2	23.9	46.6	41.8	46.6
Trifluralin	¾ lb.	31.9	21.8	21.2	38.4	31.8	32.9
Trifluralin	1 lb.	21.5	23.1	17.3	27.3	27.0	28.6
Isopropalin	1 lb.	32.9	27.9	22.8	47.7	38.4	41.9
Isopropalin	1½ lb.	34.5	32.3	23.5	38.7	36.3	36.4
Isopropalin	2 lb.	34.1	25.3	20.5	35.3	30.7	27.8
Untreated		39.0	24.6	25.2	46.5	43.9	42.6

[a]After 7, 10, or 14 days in soil temperature tank, tomatoes were moved to 22 C greenhouse.

[b]Average dry weight (mg) after 28 days

Table 3. Effects of Trifluralin and Isopropalin on Direct Seeded Tomatoes.

Treatment		1969 Phyto-toxicity[a]	1969 Mean Temp.[b]	1969 Rainfall (inches)[c]	1970 Phyto-toxicity	1970 Mean Temp.	1970 Rainfall (inches)	1971 Phyto-toxicity	1971 Mean Temp.	1971 Rainfall (inches)
Trifluralin	½ lb.	5.7	14.6 C	0.0	3.2	10.1 C	2.46	3.0	14.1 C	1.95
Isopropalin	¾ lb.	3.3	14.6 C	0.0	....			....		
Isopropalin	1 lb.	....			2.7	10.1 C	2.46	1.0	14.1 C	1.95
Isopropalin	1½ lb.	4.0	14.6 C	0.0	....			....		

[a]Phytotoxicity rating: 0 = no injury; 10 = lethal

[b]Average mean temperature for 14 day period following planting

[c]Total rainfall during 14 day period following planting

These studies indicate that there are definite temperature-herbicide rate interactions with tomato seedlings. The degree of injury is a result of the interactions among herbicide dosage, temperature at which the seedlings are grown, and length of time the seedlings are exposed to the herbicide at the low temperature.

Trifluralin and isopropalin have been included in our field trials for 3 years. In 1969, direct-seeded tomatoes were severely injured by trifluralin at ½ lb/A. Temperature records for 1969, 1970 and 1971 were compared with field injury ratings but the precise correlation between temperature and seedling injury that was observed in the laboratory was not demonstrated (Table 3). The most severe seedling injury at the ½ lb/A dosage of trifluralin occurred in 1969. 1969 was also the warmest of the three years with a mean temperature of 14.6 C for the 14 day period immediately following treatment.

The 1969 season was much drier than 1970 or 1971 (Table 3). No rainfall was recorded during the 17-day period immediately following planting, and less than ½ inch of precipitation occurred during the first month after treatment. The injury symptoms observed in the field in 1969 may have been caused by a combination of moisture stress and herbicide treatment.

Experiments were conducted in the greenhouse to determine the possible interaction between trifluralin treatment and soil moisture. Ten-inch deep flats were maintained at three moisture levels. Reduction in seedling growth correlated very well with moisture stress, but no interaction was observed between trifluralin and the moisture level.

The effect of temperature on the weed control properties of trifluralin and isopropalin on four species of annual weeds was studied (Table 4). Redroot pigweed, wild oat, ryegrass, and barnyard grass showed greater susceptibility to herbicide injury at 18 C than 13 C. The ½ lb/A trifluralin treatment gave commercially acceptable weed control (90%) when the soil temperature was 18 C, but did not give complete weed control when the soil temperature was 13 C. Isopropalin was even less effective at the lower temperature.

A relationship exists between the degree of weed control, the degree of injury to tomato seedlings, soil temperature, and the soil concentrations of the trifluralin and isopropalin treatments. If environmental conditions in Northern Utah were such that the soil temperature at planting time was relatively warm and adequate moisture was available, a satisfactory weed control could be obtained at the ½ lb/A trifluralin and this treatment would be acceptable for direct-seeded tomatoes. As soil temperature and moisture during late April and early May are unreliable and

Table 4. Effects of Soil Temperature on Weed Control

Treatment		Soil Temp. (C)[a]	Pigweed[b]	Wild Oat	Ryegrass	Barnyard Grass
Trifluralin	½ lb.	13	4.5	9	4.5	7.5
Trifluralin	¾ lb.	13	5	10	9	9
Trifluralin	1 lb.	13	6	10	10	10
Trifluralin	½ lb.	18	9	9.5	10	9.5
Trifluralin	¾ lb.	18	8.5	10	10	10
Trifluralin	1 lb.	18	9	10	10	10
Isopropalin	1 lb.	13	5	1	6	5
Isopropalin	1½ lb.	13	7	2.5	7	6.5
Isopropalin	2 lb.	13	9	5	8	8
Isopropalin	1 lb.	18	9	9	8	7
Isopropalin	1½ lb.	18	8.5	10	10	7.5
Isopropalin	2 lb.	18	9	10	10	8
Untreated			0	0	0	0

[a]Seedlings grown in soil temperature tank for 14 days after treatment, then moved to 22 C greenhouse.

[b]Weed control ratings at 28 days after treatment: 0 = no control; 10 = complete control.

often cold, there is a high degree of risk with trifluralin treatment on direct-seeded tomatoes. On the other hand, tomatoes exhibit a greater tolerance to isopropalin. A 1 lb/A treatment of isopropalin does not give as complete weed control at ½ lb/A treatment of trifluralin, but this treatment poses much less hazard to seedling tomatoes and could be recommended for direct-seeding of tomatoes when and if it were labelled for this purpose.

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Evaluation of CGA-10832 and Other Herbicides for Cotton in Arizona and California

D. W. Ragsdale and J. A. Norton[1]

Introduction

CGA-10832 is a new preplant incorporated herbicide being developed by Geigy Agricultural Chemicals, Division of CIBA-GEIGY Corporation. It has been extensively tested for weed control in cotton throughout the West. The West, in this case, will include only Arizona and California.

It is a substituted dinitroaniline compound which is biologically similar in many respects to other herbicides in this group, but with interesting and important differences, a four pound per gallon emulsifiable concentrate formulation has been studied over the past three years for biological effectiveness and crop tolerance. In addition to cotton a large variety of important U.S. crops have demonstrated selectivity, including soybeans, peanuts, dry beans, southern peas, okra, alfalfa, peas, potatoes, safflower, snap beans, other large seeded legumes, transplanted crops and perennial fruit, nut and ornamental crops.

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[1]Geigy Agricultural Chemicals Div., CIBA-GEIGY Corp., Ardsley, New York.

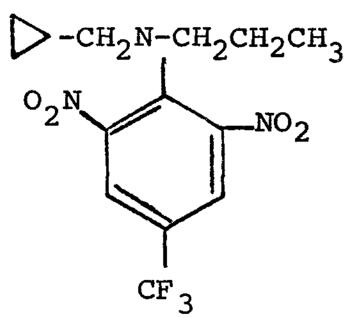
During 1971, CGA-10832 was included in tests on cotton in California and Arizona by Geigy Research Personnel and outside cooperators. Cotton has demonstrated excellent tolerance to CGA-10832 with no significant effects on crop growth or root development at rates up to 4 lb ai/acre and with acceptable control of most prevalent weeds from 0.75 lb to 3 lb ai/acre.

Weed species which have been selectively controlled with CGA-10832 include: nettleleaf goosefoot, purslane, knotweed, lambsquarters, Mexican morningglory and pigweed. Grasses controlled are: Japanese millet, browntop panicum, junglerice, barnyardgrass, red sprangletop, sandbar, annual ryegrass and seedling johnsongrass.

The physical and chemical data presently available indicate the following:

Chemical Name:
N-n-propyl-*N*-cyclopropylmethyl-4-trifluoromethyl-2, 6-dinitroaniline

Chemical Structure:



Empirical Formula: $C_{14}H_{16}N_3O_4F_3$

Molecular Weight: 347.33

Physical Appearance: Yellow-orange crystals, or deep red-orange liquid

Approximate Melting Point: 33-36°C

Solubility:
- In water at 25°C 0.1 ppm
- 50% in aromatic and aliphatic hydrocarbons (e. g. ketones)
- 25% in lower alcohols

Results of toxicological studies are as follows:
- Acute oral LD_{50} (rats) 10,000 mg/kg
- Acute dermal LD_{50} (rabbits) 3,160 mg/kg
- Acute inhalation exposure (rats) — LC_{50} 28 mg/liter (1 hr. exposure)
- Acute eye irritation — slight to moderate
- Irritation completely subsided after 4 to 7 days.

CGA-10832 has been tested by various means of application and incorporation and in one trial no incorporation at all was used. Thorough and immediate mixing of the herbicide from 2 to 4 inches deep in a soil free of trash and clods has consistently given better results, although the single preemergent trial established in Arizona showed some promise.

Relatively high temperatures at or soon after application have enhanced weed control. Certain problem broadleaved weeds such as cocklebur, groundcherry, jimsonweed, ragweed and velvet-leaf have not been controlled consistently with CGA-10832, and may require supplemental cultivation or the use of other herbicides in combination or preemergence.

Methods and Materials

This report includes results of cotton trials conducted solely within the western states by research personnel of Geigy Agricultural Chemicals during 1971. All studies reported here have included various rates and application methods of CGA-10832, two other dinitroanilines which were under test by Geigy Agricultural Chemicals (i.e. CGA-11607 or GS-38946 and CGA-14397 or GS-39985)*, and several commercial standard cotton herbicides. These studies consisted of various plot sizes and included various weed species, soil types and climatic conditions. All data include three or four replications and some include up to three ratings, usually taken at monthly intervals after application. Only the 4 lb/gallon formulation of CGA-10832 was used.

The tests were applied with tractor mounted or back pack CO_2 sprayer utilizing 20 to 40 psi pressure and 10 to 30 gallons per acre of water volume. Incorporation of the herbicides to various depths was conducted soon after application by disc, rolling cultivator, power rotavator, lilliston rolling cultivator and other various pieces of farm equipment.

Results and Discussion

In Table 1, data are summarized from a Geigy Farm at Fresno, California. This trial was applied PPI to a sandy loam soil in April 1971 and rated in June of the same year. Incorporation was both deep and shallow, with the shallow incorporation ranging to 3 inches and the deeper incorporation to 5 and 6 inches. The shallow incorporation gave slightly better control, and only these data were included in Table 1. CGA-10832 was applied at 0.5, 0.75 1.0, 1.5 and 3 lb ai/A and trifluralin was applied at 0.5, 0.75 and 3.0 lb ai/A.

*CGA-11607 = *N*-ethyl-*N*-tetrahydrofurfuryl-4-trifluoromethyl-2-6-dinitroaniline

CGA-14397 = *N*-n-propyl-*N*-tetrahydrofurfuryl-4-trifluoromethyl-2, 6-dinitroaniline

Comparative results show a slight edge for trifluralin in the control of broadleaved weeds (mainly mustards) in this particular trial. Grassy weeds, including volunteer barley, were controlled almost equally well by both CGA-10832 and trifluralin. Where dashes are shown, the compound was not applied at those rates.

Results from another Geigy Farm trial are shown in Table 2. This trial was applied PPI to a sandy loam soil on May 11, 1971, with only three rates of both CGA-10832 and trifluralin. Weed control ratings were made 30 days later. Broadleaf weed control at all rates was poor in this test. This suggests that for consistent control of all broadleaf weeds the addition of another herbicide may be needed either PPI or preemergence. The primary target ("Grassy Weeds") showed comparable control from both compounds, with slightly better control at all rates of trifluralin. In this test, increasing the rate of CGA-10832 did not appear to increase the effectiveness of grass control significantly.

In Table 3, an Arizona trial is summarized. In this trial, both CGA-10832 and trifluralin were applied PPI on March 10, 1971 to a loam soil and rated in April, June and August. Broadleaf and grassy weed control was acceptable at all rates of application. Again, a slightly better control was noted in the trifluralin treatments.

In another Arizona study (Table 4), preemergence applications were made to a silt loam soil on March 10, 1971, followed by a thorough furrow irrigation 10 days later. The CGA-10832 and trifluralin were applied at 0.75· 1.05 and 3 lb/acre on the surface over preformed and planted beds. Weed control ratings were made on May 3. Weed infestations were so light and variable that accurate evaluations were difficult. CGA-10832 showed good control of broadleaf weeds at 0.75 and 1.5 lb ai/acre but was relatively poor at 3 lb/acre. Both compounds showed excellent grass control at 0.75 lb. At 1.5 lb/acre, both compounds gave commercially acceptable grass control, although CGA-10832 appeared to be less effective than at the lower rate.

In Table 5, which shows results from a trial applied April 7, 1971 near Yuma, Arizona on a sandy loam soil, CGA-10832 and trifluralin were applied at 0.75 and 1.5 lb/acre. Incorporation was accomplished immediately by a Lilliston rolling cultivator on a previously bedded field. Plots were rated on May 4, 1971. At 0.75 lb/A, exceptionally good broadleaf weed control was obtained with both compounds, with a slight advantage for CGA-10832. At the 1.5 lb rate, the compounds were equal in broadleaf weed control. Grassy weeds were controlled 100% by all treatments in this trial. The large amounts of water used and the immediate incorporation in the upper 2 to 3 inches probably accounted for the outstanding weed control in this trial.

The average control percentages from many cotton trials for CGA-10832 and trifluralin are summarized in Table 6. The average percentage control from 0.75, 1 and 1.5 lb/acre of CGA-10832 is 90, 81 and 87%, respectively. Essentially, very little difference was observed from 0.75 to 1.5 lb ai/A. At the same rates of trifluralin, we see essentially the same amount of control, with a slightly better average grass control observed in the trifluralin treatments.

In Table 7, the average broadleaf weed control from 0.75, 1, 1.5 and 3 lb/acre of CGA-10832 was 75%, 50%· 93% and 80% control, respectively. It should be pointed out that the 50% and 60% average control at 1 lb/acre of CGA-10832 and trifluralin, respectively, were from only two tests. Otherwise, broadleaf weed control was quite comparable for the two compounds.

Summary and Conclusions

CGA-10832 has considerable commercial potential for weed control in cotton. Annual and seedling grasses and many broad-leaved weeds can be consistently and effectively controlled by preplant incorporation of 0.75 to 3 lb/acre CGA-10832. The rate will depend a great deal on soil type, weed species and weather conditions at the time of application, and whether a supplemental cultivation or additional herbicide applications will be made. In most cases, the early ratings from all dinitroaniline herbicides showed significantly better weed control compared to ratings which were made a month later, mainly because of the increased size of the weeds which survived. A timely cultivation followed by an application of CGA-10832 would usually be sufficient to result in a very clean cotton field throughout the season.

Cotton tolerance of CGA-10832 has been excellent. Crop tolerance data were not included in the tables since the treated plots showed cotton tolerance equal to the untreated checks in almost every instance.

The compound demonstrates an even greater margin of selectivity when compared with some other dinitroaniline herbicides. This should be a significant advantage, resulting in greater flexibility in the use of CGA-10832 by allowing a higher rate for improved control of problem weeds. Extensive work is also underway to determine the effect of fall, winter and early spring treatments on the performance of CGA-10832.

While studies on residual life or accumulative effects in soil from repeat applications of CGA-10832 are still in progress, preliminary results show that no injury to rotational crops or undesirable ecological effects should occur. Comparative studies have demonstrated that CGA-10832 is less persistant, or causes less injury to sensitive crops planted after application than trifluralin, in many cases.

Several weed scientists in the western United States feel this compound, CGA-10832, is as close to the standard in its performance as could possibly be expected from two dinitroanilines.

WEEDS CONTROLLED BY CGA-10832 4E

Broadleaf Weeds

Pigweed (*Amaranthus* species)
Purslane (*Portulaca* species)
Lambsquarters (*Chenopodium* species)
Goosefoot (*Chenopodium* species)
Silversheath knotweed (*Polygonum argyrocoleon*)
Annual morningglory (*Ipomoea* species)

Grassy Weeds

Annual ryegrass
Sandbur (*Cenchrus* species)
Annual bluegrass (*Poa annua*)
Sprangletop (*Leptochloa* species)
Millet (*Setaria* species)
Browntop panicum (*Panicum* species)
Junglerice (*Echinochloa colonum*)
Stinkgrass (*Eragrostis cilianensis*)

Table 1. Fresno Geigy California Farm 09-71

Applied: 4/30/71 (shallow incorporation 0-3")
Rated: 6/10/71
Sandy Loam Soil

CGA-10832/Trifluralin	Broadleaf Weeds	Grassy Weeds
0.5 lb ai/A	46/73	63/76
0.75 lb ai/A	50/70	83/86
1.0 lb ai/A	60/-	86/-
1.5 lb ai/A	60/-	90/-
3.0 lb ai/A	66/86	93/93

Table 2 Fresno Geigy California Farm 10-71

Applied: 5/11/71
Rated: 6/11/71
Sandy Loam Soil

CGA-10832/Trifluralin	Broadleaf Weeds	Grassy Weeds
0.5 lb ai/A	20/30	70/82
0.75 lb ai/A	47/35	77/85
1.0 lb. ai/A	40/60	70/87

Table 3 W-H-13-71 Casa Grande, Arizona

Applied: 3/10/71
Rated: April, June and August — Average shown
Loam Soil

CGA-10832/Trifluralin	Broadleaf Weeds	Grassy Weeds
0.75 lb ai/A	70/67	70/86
1.5 lb ai/A	78/80	87/94
3.0 lb ai/A	85/94	91/95

Table 4. W-H-14-71 Casa Grande, Arizona

Applied: 3/10/71
Rated: 5/3/71
Silty Loam Soil

CGA-10832/Trifluralin	Broadleaf Weeds	Grassy Weeds
0.75 lb ai/A	96/-	100/98
1.5 lb ai/A	90/96	72/100
3.0 lb ai/A	65/72	-/100

Table 5. W-H-23-71 Yuma, Arizona

Applied: 4/7/71
Rated: 5/4/71
Sandy Loam Soil

CGA-10832/Trifluralin	Broadleaf Weeds	Grassy Weeds
0.75 lb ai/A	100/90	100/100
1.5 lb ai/A	95/95	100/100

Table 6. Average Grassy Weed Control

CGA-10832/Trifluralin	Percent Control
0.75 lb ai/A	90/81
1.0 lb ai/A	81/91
1.5 lb ai/A	87/100

Table 7. Average Broadleaved Weed Control

CGA-10832/Trifluralin	Percent Control
0.75 lb ai/A	75/72
1.0 lb ai/A	50/60
1.5 lb ai/A	93/82
3.0 lb ai/A	80/81

Residues in Crops Treated with TCA in Irrigation Water[1]

R. J. Demint and J. C. Pringle, Jr.[2]

Abstract. Irrigation water was treated with 0.1 and 0.5 ppm of trichloroacetic acid (TCA) to simulate the average residue and five times the average residue found in water turned into canals in the spring following fall ditchbank treatment with TCA at 73 lb/A. The TCA-bearing water was used to furrow irrigate eight crops on several farm units in the Columbia Basin. The crops were analyzed by a procedure which consisted of an acid hydrolysis of the TCA in crops. Chloroform derived from the TCA was distilled into

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toluene and quantitated by electron capture detector gas chromatography. The lower limit of detection was 0.01 ppm of TCA with an average of 92%. Less than 0.01 ppm of TCA was found in potatoes (*Solanum tuberosum* L.), sugarbeets (*Beta vulgaris* L.) and wheat (*Triticum aestivum* L.) treated at all rates. Maximum TCA residues of 0.01, 0.02, 0.04, and 0.04 ppm were found in green immature corn plants (*Zea mays* L.), whole dry green peas (*Pisum sativum* L.), alfalfa (*Medicago sativa* L.), and watermelon plants (*Citrullus vulgaris* Schrad.) treated at the highest rate, respectively. TCA residues of 0.4 ppm were found in pinto bean plants (*Phaseolus vulgaris* L.) in the flowering stage collected 7 days after treatment; however, the mature dry beans did not contain measureable quantities of TCA. At the lower TCA rate of 0.1 ppm, residues of 0.01 ppm of TCA were found in alfalfa and green peas and 0.02 ppm in pinto bean plants. No measureable residues were found in the other crops treated at the lower rate.

Persistence of Herbicides in Fallow Desert Cropland

H. F. Arle and K. C. Hamilton[1]

The persistence of herbicide study which is being reported varies somewhat from most residue type experiments. Our experiment was designed to study the persistence of herbicides when application was followed by various periods of fallow. Four herbicides frequently used in Arizona agriculture were included in this study. We have been criticized by some chemical company representatives who thought that the conditions of the experiment do not represent situations encountered in agriculture. However, in desert agriculture this situation is more possible than in other areas. Following application of an herbicide it is not completely unusual for a change in farming plans to occur with the result that treated land may not be farmed for a period of time. These changes in plans may be caused because the acreage treated was in excess of allotments. The supply of irrigation water may be in short supply and cause temporary abandonment of some acreage. Change of ownership frequently results in management plans which deviate from those of the previous owner. Under our conditions of low rainfall and minimum organic matter in the soil the potential for herbicide persistence is at a higher level than in most agricultural areas. Similar experiments were conducted at University of Arizona Experiment Stations located at Mesa and Yuma, Arizona.

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At each location trifluralin at .8 lb/A, and prometryne, diuron and atrazine were applied at 1.6 lb/A. Treated plots and an untreated check were replicated 3 times. Our rates of application were similar to those frequently used in this area for selective weed control in crops. The first series of treatments were made during the fall of 1968 during October at Mesa and in November at Yuma. The same treatment were repeated on adjacent areas at intervals of six months — during the spring and fall of 1969 and again during the spring and fall of 1970. Following each application, herbicides were soil incorporated by disking to a depth of 6 inches. Following each of the first four application dates, treated areas remained fallow until crops were planted shortly after the applications were made in fall 1970. This schedule resulted in fallow periods of 24, 18, 12, 6 and 0 months between treatment and planting.

The experimental areas had been in irrigated crop production for over 50 years prior to beginning the experiments. The soils at the two locations differed considerably in sand and clay content the Yuma soil being very high in clay and silt and containing only 4% sand. Organic matter was very low at both stations. During the fallow period the only moisture reaching the soil was rainfall. Rainfall totaled slightly over 15 inches at Mesa and 6 inches at Yuma during the 2-year period. This is average for each location.

Eight crops were planted at each location shortly after the final applications were made during October 1970. Included were 4 agronomic crops (alfalfa, barley, sugarbeets and safflower) and 4 horticultural crops (lettuce, onions, cabbage and carrots). Seed were shallowly planted in dry soil and germinated by a postplanting irrigation. Effect on crop plants was measured by determining plant populations about two months after emergence and by obtaining fresh weight of top growth at a later date (4 months after planting). The fall-planted crops were irrigated to maintain normal growth, 16 inches of water being applied in 5 irrigations. These crops were destroyed in March and 4 spring crops were planted. These included cotton, soybeans, corn and sorghum. These crops were grown for several months. Crop populations and fresh weight of top growth data were again obtained. In October of 1971 the same 8 crops were planted as during the previous fall. Weekly observations of crop development were made, but stand and green weight were not measured because no herbicide symptoms were visible on any crop.

Results

The initial emergence of most crops was not affected by herbicide treatments. However, 7 to 10 days after emergence stunted or injured seedlings were evident with certain treatments. The stands of all fall-planted (1970) crops were affected by one or more herbicides at one or both locations. Stand reductions for most crops were more severe at Mesa than at Yuma. At Yuma stands of barley, safflower and onions were not significantly reduced by any herbicide regardless of application time. Sugarbeets and cabbage were most sensitive to residues of these herbicides. Diuron and atrazine appeared most persistent and affected more crops 24 months after treatment than did other herbicides. After 24 months diuron significantly reduced stands of only cabbage at Yuma but at Mesa reduced stands of all crops except carrots. Average stand of carrots, however, was rather low at 18 months for diuron and also atrazine.

Trifluralin had less effect on crops than other herbicides. However, at both locations sugarbeet stands were reduced after 24 months and at Yuma these differences were significant. In crops such as lettuce and cabbage at Yuma stands were significantly reduced by atrazine, diuron and prometryne treatments but fresh weights were not significantly different from untreated checks at any date. Increased growth of surviving plants compensated for reduced stands. However, the response of sugarbeets to trifluralin was different at Yuma, stand reductions occurred and in addition sugarbeet plants remained stunted and fresh weights of top growth were greatly reduced.

When we combine data obtained for each crop from the 5 application dates we find that crops were more sensitive to herbicide residues at Mesa than at Yuma although Mesa received twice as much rainfall during the fallow period. Temperatures are somewhat higher at Yuma, especially during summer months. The high clay and low sand content at Yuma were probably the major factors in the lesser crop injury at that location.

Fur summer crops, cotton sorghum, corn and soybeans, were planted during spring 1969 (following the 8 crops planted in fall 1968), 30 months after the initial treatments. Some of the herbicides were still present in sufficient concentration to injure crops. Diuron reduced stands of sorghum after 30 months and corn after 24 months at Mesa. Atrazine reduced soybean stands 6 months after application at Yuma and 12 months after application at Mesa and trifluralin reduced sorghum stands 12 months after application at Mesa.

Herbicide residues had a greater effect on green weights than on stands of the spring-planted crops. One or more herbicides reduced green weights of top growth of all crops at Mesa and all crops except corn at Yuma. Thirty months after treatment diuron reduced green weights of soybeans, corn and sorghum at Mesa and trifluralin reduced green weights of sorghum at Yuma.

Breakdown of herbicides apparently was rapid during the time these crops were grown. When the same 8 crops planted in the fall of 1970 were again planted during October 1971 (36 months after 1st treatments and only 12 months after last applications) there was no further evidence of stand reduction or growth retardation.

Persistence of herbicide residues in fallow desert soils can affect susceptible crops planted 1, 2 or more years after herbicides are applied. Present herbicide labels indicate crops can be safely planted after 1 or 2 years. This is definitely not the case where herbicide degradation has not occurred because of lack of soil moisture. In many desert soils the rainfall is inadequate to allow herbicide degradation because the amounts are low and the rainfall may occur when temperatures are low and rate of microbial degradation reduced.

Factors Controlling Crystallizing-Out of Phenmedipham in the Spray Solution

Robert F. Norris[1]

Phenmedipham, used in the commercial herbicide Betanal,[2] has been reported to crystallize-out in the spray solution. This process has been found to depend on dilution. No crystallization occurs at dilutions of 1 part Betanal to 25 parts water or less. A dilution of 1:30 Betanal:water resulted in approximately 2% of the phenmedipham having crystallized out after 48 hours. Increased dilution leads to greatly increased crystallization. At 1:50 Betanal:water 70% of the phenmedipham crystallized out, and over 90% crystallized out at 1:100 dilution or greater. Increased dilution also greatly increased the rapidity of the crystal lization process; at 1:40 it took 12 hours before significant crystallization occurred, at 1:100 50% of the phenmedipham crystallized out in 1.5 hours. The rate of crystallization from the solution was doubled over the first 12 hours after mixing if the solution was mechanically agitated. Lower temperatures accelerated the crystallization process; at 5°C 40% of the phenmedipham crystallized from a 1:30 Betanal:water mixture but at 25° none crystallized out. Thirty percent of the phenmedipham in a 1:40 dilution crystallized out in 6 hours at 5°C; only 2% crystallized out in the same time at 25°C. Simulated addition of water to a partially empty spray tank during refilling created severe crystallization problems, adding Betanal before refilling minimized this crystallization. Water at 10°C used to simulate refilling caused greater crystallization

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[2]Trademark of Noram.

than water at 35°C. There was no difference in crystallization between tap (hard) or distilled water, or between water at pH 4, 6 or 8. The crystallization problem will be discussed in light of classified partitioning concepts.

Yellow Nutsedge and Cotton Response to Several Herbicides[1]

P. E. Keeley, C. H. Carter, and J. H. Miller[2]

Abstract. Herbicides that controlled nutsedge in greenhouse experiments were evaluated for the control of yellow nutsedge (*Cyperus esculentus* L.) in cotton (*Gossypium hirsutum* L. 'Acala SJ-1') in three field experiments during 1970 and 1971. The herbicides, 2-chloro-2', 6'-diethyl-*N*-(methoxymethyl) acetanilide (alachlor); 2-chloro-2', 6'-diethyl-*N*-(butoxymethyl) acetanilide (CP-53619); 2,4-bis(isopropylamino)-6-(methylthio)-s-triazine (prometryne); 2-*a*-naphthoxy)-*N*,*N*-diethyl-propionamide (R-7465); S-isopropyl 5-ethyl-2-methyl-piperidine-1-carbothioate (R-12001); 4-chloro-5-(dimethylamino)-2-(*a, a, a*-trifluoro-*m*-tolyl)-3(2*H*)-pyridazinone (San-6706); and 2-(3,4-dichlorophenyl)-4-methyl-1,2,4,-oxadiazolidine-3, 5-dione (VCS-438), were applied broadcast and incorporated 4 inches deep into a fine sandy loam before the preplanting irrigation. Plots were cultivated two or three times and furrow irrigated biweekly.

Most treatments provided acceptable control of nutsedge (80% or greater as measured by visual ratings and plant counts). R-7465 at 1, 2, and 4 lb/A, R-12001 at 1.5 and 3.0 lb/A, San-6706 at 1, 2, and 4 lb/A, and VCS-438 at 2 and 4 lb/A controlled nutsedge for 2 to 6 months. CP-53619 at 2 and 4 lb/A and alachlor at 1 and 2 lb/A controlled nutsedge in two experiments conducted in 1971 when rain occurred after planting, but alachlor provided only 4 weeks control. Prometryne at 3 lb/A provided marginal control of nutsedge in two experiments and acceptable control of nutsedge in one experiment.

Cotton tolerance for treatment with 2 or 4 lb/A of CP-53619, 3 lb/A of prometryne, 1 lb/A of San-6706, or 2 lb/A of VCS-438 appeared greater than that for the other treatments. None of these treatments, compared with hand-weeding, reduced seed-cotton yields or cotton stands by more than 20 percent in any experiment. Most of the remaining treatments reduced yields or stands by at least 25 percent in one or more experiments.

[1]Cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the California Agricultural Experiment Station.

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Control of Weeds in Grass on Roadsides in New Mexico

P. C. Quimby, Jr.[1], R. L. McDonald[1], R. G. Lohmiller[2] and R L Brammer[3]

Abstract. Twenty-eight herbicide treatments were applied in replicated trials at 3 locations along interstate highways near Albuquerque, New Mexico. The objective was to find a control for kochia [*Kochia scoparia* (L.) Schrad.] and Russian thistle (*Salsola kali* L. var. *tenuifolia* Tausch), without injury to endemic and artificially seeded native grasses. The principal grasses were: blue grama [*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.]; sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.]; sand dropseed [*Sporobolus cryptandrus* (Torr.) A. Gray.]; western wheatgrass (*Agropyron smithii* Rydb.); and Indian ricegrass [*Oryzopsis hymenoides* (Roem. and Schult.) Ricker].

A performance index (PI) score was calculated for each treatment. The PI was equal to the weed control score minus percent injury to grasses. PI scores were compared with that of 5-bromo-3-*sec* butyl-6-methyluracil (bromacil) at 2 lb/A as a standard.

The PI scores for seven treatments were significantly (P=.01) higher than the score for bromacil. The seven treatments were: 3,5-dibromo-4-hydroxybenzonitrile (bromoxynil) at 0.5 and 1 lb/A; the amine salt of (2,4-dichlorophenoxy) acetic acid (2,4-D) at 3 lb/A; 2,4-D amine plus 2-(3,4-dichlorophenyl)-4-methyl-1, 2, 4-oxadiazolidine-3, 5-dione (VCS-438) at 1+1 and 1+3 lb/A; 2,4-D amine plus 2,4-D amide at 1+1 lb/A; and 3,6-dichloro-*o*-anisic acid (dicamba) at 1 lb/A. Each of these seven treatments provided 70% or greater average weed control with less than 25% average injury to the grasses. (Cooperative investigations of the Plant Science Research Division, Agricultural Research Service and Soil Conservation Service, U.S. Department of Agriculture, New Mexico State Highway Department, and New Mexico State University. This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have

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[3]Horticulturist, New Mexico State Highway Department.

been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.)

Herbicides for Control of Saplings of Pinon and Utah Junipers in Areas Previously Mechanically Treated

James A. Young and Raymond A. Evans[2]

A heavy chain or cable drawn between two large tractors is widely employed in the western United States to up-root pinon and juniper trees. Saplings, up to 2 m tall are sufficiently supple to be bent-over by the chain without being up-rooted and whip upright after it passes.

We employed basal area treatments of 7, 14, 28, 70, or 140 g/tree of granular m-(3,3-dimethylureido) phenyl-tert-butylcarbanate (karlbutilate) or 4-amino-3,5,6-trichloropicolinic acid (picloram) on previously chained mixed stands of one-leaf pinon (*Pinus monophylla* Torr. & Frem.) and Utah juniper (*Juniperus osteosperma* (Torr.) Little. In stands lccated on sandy loam soils derived from decomposing granite, saplings were completely controlled by either 14 g/tree of karbutilate or picloram. The 7 g/tree rate of karbutilate was effective on seedlings up to 0.5 m tall, however, injury symptoms were noted on all taller saplings. The same rate of picloram was effective on saplings 1 m tall and caused severe injury to trees to 2 m in height. In stands located on heavy clay soils, higher rates of both herbicides were required to obtain comparative levels of control. The onset of symptoms of injury from karbutilate was greatly delayed on the sites with clay soils and down-slope movement of the herbicide on the soil surface was apparent. At the rates employed, picloram did not cause injury to understory grasses. All rates of karbutilate caused injury to understory grasses. No selectivity was found with either herbicide for leaving desirable shrubs growing between the saplings.

Effect of Nitrogen on Miserotoxin Metabolism in Three Varieties of Timber Milkvetch

Robert Parker and M Coburn Williams[1]

Wasatch milkvetch (*Astragalus miser* var. *oblongifolius* (Rydb.) Cron.), Yellowstone milkvetch (*Astragalus miser* var. *hylophilus* (Rydb.) Barneby) and Columbia milkvetch (*Astragalus miser* var. *serotinus* (Gray) Barneby) contain miserotoxin, a toxic nitro sugar, which metabolizes to 3-nitro-1-propanol in ruminants. Columbia milkvetch causes more cattle losses in British Columbia than any other poisonous plant.

We are currently investigating the effect of nitrogen fertilization on the miserotoxin level in the three varieties. Nitrogen comprises 5.2 percent of the miserotoxin molecule and may be the limiting factor in the metabolism of the poison.

Ammonium sulfate, ammonium nitrate and potassium nitrate were applied at 50 and 100 lb/A N in the spring and fall to Wasatch milkvetch near Manti and Logan, Utah; Yellowstone milkvetch near Jackson, Wyoming; and Columbia milkvetch near Winthrop, Washington. Plants were collected biweekly and analyzed for percent miserotoxin and nitrogen.

The nitrogen content of both treated and untreated Wasatch and Yellowstone milkvetch averaged 3 to 4 percent during early flower when plants were most poisonous. Three to 4 percent of the total nitrogen was incorporated in the miserotoxin. Miserotoxin content of Wasatch and Yellowstone milkvetch rarely exceeded 3 percent regardless of treatment; whereas, untreated Columbia milkvetch in early flower contained 6 percent miserotoxin. Columbia milkvetch from fertilized plots contained up to 16 percent miserotoxin. In both treated and untreated Columbia milkvetch approximately 14 percent of the total nitrogen was incorporated in miserotoxin. Two weeks later, when Columbia milkvetch was in full flower, nitrogen content remained the same but miserctoxin concentration dropped to between 2 and 3 percent in both treated and untreated plants.

Karbutilate for Simultaneous Brush and Herbaceous Weed Control for Fallowing and Reseeding on Rangelands

Raymond A. Evans and James A. Young[1]

Degraded big sagebrush (*Artemisia tridentata* Nutt.) communities often contain green rabbitbrush (*Chrysothamnus viscidiflorus* (Hook.) Nutt.) which makes herbicidal control of shrubs difficult. If an understory of downy brome (*Bromus tectorum* L.) is present, it may be imposible to establish desirable perennial grasses without herbaceous weed control.

Applications of the herbicide m-(3,3-dimethylureido) phenyl-tertbutylcarbamate (karbutilate) made it possible to simultaneously control woody and herbaceous species which created a chemical fallow for re-

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[1]ARS-USDA, Plant Science Res., Univ. of Nev., RNR, 920 Valley Road, Reno, Nevada 89502.

seeding. Applications of 0.6 to 0.8 kg/ha in the fall controlled downy brome or Sandberg bluegrass (*Poa secunda* Presl.), but did not give complete control of rabbitbrush. Application of 1.1 kg/ha controlled both rabbitbrush and herbaceous weeds. In areas where this rate of karbutilate was applied, intermediate wheatgrass (*Agropyron intermedium* (Host.) Beauv.) was seeded the following fall without injury to the seedlings. In dense big sagebrush stands, it was necessary to increase the rate to 1.7 kg/ha to obtain complete brush control. In this type of stand, distributing granular herbicide under the brush canopies was difficult. Intermediate wheatgrass seedlings were severely injured but not completely killed when karbutilate was applied at 4.5 kg/ha to create the fallow. At this rate of karbutilate, sufficient herbicide activity remained to control annual species during the seedling year.

An Evaluation of Paraquat for the Control of Geyer Larkspur and its Effect on Grass Production

Ted R. Warfield, H. P. Alley, G. A. Lee[1]

Abstract. Paraquat (1,1'-dimethyl-4,4-bipyridinium ion) was applied at 0.5 lb/A, 1.0 lb/A and 2.0 lb/A on five treatment dates between April 29, 1971 and June 5, 1971 to evaluate larkspur (*Delphinium geyeri* Greene) control and the effect upon grass production. All applications were made with a knapsack sprayer to replicated 2 square rod plots in a total volume of 40 gpa water with X-77 added at 8 oz/100 gal mix as a wetting agent.

The treatments of paraquat at later dates gave the best knockdown of the Geyer larkspur with the May 28, 1971 treatment giving the best results. The 0.5 lb/A treatment gave from 88-99 percent, 1.0 lb/A-92-100 percent, and the 2.0 lb/A - 91-100 percent knockdown of larkspur.

The early applications reduced the total grass production more severely than the later treatment dates. The 2.0 lb/A treatment decreased grass production an average of 64 percent, the 1.0 lb/A an average of 54 percent, and the 0.5 lb/A an average of 49 percent of the untreated plots. The major grasses present were Blue Grama (*Bouteloua gracilis* (H.B.K.)), Prairie Junegrass (*Koeleria cristata* L.), Needleandthread (*Stipa comata* Trin. and Rupr.), Sandberg bluegrass (*Poa secunda* Pres.), Western wheatgrass (*Agropyron smithii* Rydb.), *Carex* spp. Indian ricegrass (*Oryzopsis hymenoides* Roem. and Schult.). (Wyoming Agriculture Experiment Station, Laramie, SA-371).

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Chemical Control of Pricklypear Cactus (Opuntia Polyacantha Haw.) as Affected by Date of Herbicide Applications

D. A. Schmer, H. P. Alley and Gary Lee[1]

Abstract. Chemical control of pricklypear has been accepted as a range improvement practice in Wyoming and has been included in the state ACP cost sharing program. Aerial application of silvex (2,4,5-TP) is a very effective treatment in most cases.

Recommendatoins, at the present time, state that treatments be made when pricklypear is in the early bloom stage of growth. Observations and summarization of eight years of data indicate that later treatments, July or even early August, may result in more effective control than applications made at the early bloom stage of growth.

A cooperative study was established in 1969 between Amchem Products, Inc. and the University of Wyoming. Aerial application of silvex and two new experimental compounds were applied at two different dates, approximately one month apart. Evaluations made one and two years after application showed that the July treatments of silvex were more effective than the earlier June treatments. Silvex at 1 lb/A gave only 40% control for the June treatment compared to 85% control for the July treatment when evaluated in 1970. Both treatment dates showed an increase in control from 40% to 50% and 85% to 90% when evaluated in 1971. The 2 lb/A rate of silvex when applied in June resulted in 85% control in 1970 and only 70% control in 1971 which indicates recovery of cactus pads.

The July application of silvex at 2 lb/A showed an increase in control from 96+% in 1970 to 99+% in 1971 with very few live pads.

ACP-66-60, at the 1 lb/A rate was more effective at the earlier date when evaluated in 1970, however the later date showed better control in 1971. The June application of ACP-66-60 at 2 lb/A gave 90% cntrol in 1970 and 1971, while the later application at 2 lb/A was more effective with 96+% control in 1970 and 95% control in 1971. (Wyoming Agriculture Experiment Station, Laramie, SA-370).

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Chemical Control of Broom Snakeweed and its Effect on the Short-grass Plains in Southeastern Wyoming

R. W. Gesink, H. P. Alley, and G. A. Lee[1]

Abstract. A study was initiated in 1966 to investi-

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gate the effectiveness of 2-(2,4,5-trichlorophenoxy) propionic acid (silvex), 4-amino-3,5,6-trichloropicolinic acid (picloram), and picloram plus (2,4-dichlorophenoxy) acetic acid (2,4-D) treatments in the control of broom snakeweed (*Gutierrezia sarothrae* (Pursh) Britt, and Rusby) and plains pricklypear (*Opuntia polyacantha* Haw.). The location of the 1/5 acre plots was on an overgrazed sandy range site on the short-grass plains of Southeastern Wyoming in Albany County.

Observations concerning vegetation response to the treatments were recorded each year, and in 1971 an intensive vegetation survey of the plot area was conducted by utilizing the line interception method and clip quadrats to gather quantitative data. The purpose of the survey was to evaluate the long-term influence of the herbicide treatments on the entire plant community.

All treatments which included picloram provided excellent control of both broom snakeweed and plains pricklypear, and resulted in a notable improvement in the range condition and grass production. Silvex treatments were considerably less effective, especially in regard to broom snakeweed control.

The most noticeable change was the large increase in the abundance of needleandthread (*Stripa comata* Trin. & Rupr.) on the area subjected to picloram treatments. During the first two years following the treatments the dominant grass species, blue grama (*Bouteloua gracilis* (H. B. K.) Lag.), was considerably reduced in abundance. The reduction in blue grama along with the elimination of snakeweed and pricklypear competition provided an excellent opportunity for an increase in needleandthread grass. The survey data revealed that, not only had needleandthread grass maintained its abundance in the community, but blue grama had recovered and (5 years after treatment) provided about three times as much cover and production as the untreated areas. The reaction of blue grama is similar to that observed in range pitting studies in this region where blue grama was mechanically thinned, and yet in years subsequent to treatment, the thinned stands out produced the original.

These increase in blue grama and needleandthread along with several other miscellaneous grass and forb species resulted in high total herbage production figures. The areas treated with picloram at 0.5 lb/A provided as much as 1200 lb/A oven-dried herbage, a rather substantial increase when compared to 225 lb/A from the untreated areas. (Wyoming Agriculture Experiment Station, Laramie, SA-355).

A Mechanism of 4-(2, 4-Dichlorophenoxy) Butyric Acid Selectivity

David L. King and D. E. Bayer[1]

Curly dock (*Rumex crispus*) is readily controlled in leguminous crops by a foliar 4-(2,4-dichlorophenxy) butyric acid (2,4-DB) application while buckhorn plantain (*Plantago lanceolata*) is quite resistant to this treatment. Intact plant and leaf tissue slice assays were used to investigate the factor(s) which contributed to this difference in selectivity.

Dosage-response measurements showed curly dock to be about eight times more sensitive to foliar applications of 2,4-DB triethylamine formulation. The rate of 2,4-DB required to inhibit growth of curly dock and buckhorn plantain by 50% (ED_{50}) three weeks after treatment, as determined by graphic interpolation, was 0.20 lb/a, ai and 1.60 lb/a, ai, respectively. Shoot to root ratios decreased with increasing herbicide concentration up to the ED_{50} value and then increased at progressively higher herbicide concentrations in both species. Curly dock foliage retained approximately twice as much spray volume as buckhorn plantain. Total absorption of 2,4-DB on a per plant basis was slightly greater in curly dock; however, on a per gram fresh weight basis it was two to three times greater in buckhorn plantain (Table 1). The greater uptake in buckhorn plantain indicated that penetration differences could not explain the differences in selectivity. Translocation of label from 2,4-DB-ring-UL^{14}C treated leaves increased with time (Table 2). Within 72 hours approximately 75% of the label in curly dock and 25% in buckhorn plantain had moved out of the treated leaves. The principle labeled compound transported was 2,4-D. Both species exudated about the same amount of 2,4-D. No detectable quantities of 2,4-DB were found outside of the treated leaf. After 72 hours most of the 2,4-D was present in the roots of curly dock and either the roots or treated leaf of buckhorn plantain. About three times as much 2,4-D was recovered from the roots of curly dock as from buckhorn plantain roots. Since 2,4-D is probably the toxicant, the higher levels found in the roots of curly dock could perhaps explain why it is the more susceptible species. However, the reason(s) why curly dock metabolizes two to three times more 2,4-DB to 2,4-D than buckhorn plantain was not known. The events which lead to this difference appeared to be localized in the treated leaf.

A rapid leaf tissue slice assay was developed to study these events in more detail. Leaves of uniform age were cut into thin 400 micron thick slices, sub-

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merged in buffered incubation solution containing labeled 2,4-DB or 2,4-D, and maintained under controlled temperature and lighting conditions throughout the experimental period. Cell damage resulting from sectioning with a hand microtome and observed by electron and light microscopy was restricted to the outermost layer of cells. Vital staining indicated tissue of both species was in good condition. Both species had similar respiratory rates at 25 to 30°C and the rates remained constant over the experimental period. Mesophyll cell volumes and mitochondrial distributtion and frequencies per gram fresh weight were also equivalent in curly dock and buckhorn plantain.

Total absorption of 2,4-DB on a per gram fresh weight basis in tissue slices showed the same properties as that occurring in the intact plants except that absorption was only slightly to twice as great in buckhorn plantain as in curly dock (Table 3). Kinetic data indicated that the uptake processes were approximately identical in both species. Both 2,4-DB and 2,4-D were released from slices during the incubation process. Usually two to four times more label was lost from curly dock than from buckhorn plantain slices. Similar differences were shown in desorption studies.

Oxidation of 2,4-DB-ring-UL-^{14}C to 2,4-D-ring-UL-^{14}C or $^{14}CO_2$, respectively, was about four to six times greater in curly dock than in buckhorn plantain even though comparable respiratory capabilities were shown in both species (Table 3). This followed the same trend apparent in intact plants. Malonate inhibited respiration of 2,4-DB immediately and to the same extent in both species (Table 4). Although 0.025 M imidazole inhibited respiration to a greater extent in curly dock (50%) than in buckhorn plantain (20%) the inhibition had a lag phase of two or more hours and was considerably less potent than malonate. Thus, beta oxidation appeared to be the principle way in which 2,4-DB was oxidized to 2,4-D in both species. Less than 0.05% of the 2,4-DB-ring-UL-^{14}C was degraded in curly dock and buckhorn plantain species. Both species appeared to synthesize about 1% of unidentified longer chain fatty acid-like compounds from the 2,4-DB-ring-UL-^{14}-C moiety and the total quantities of other unidentified chemicals formed were usually less than 15% of the total absorbed (Table 3). Only approximately 5% of the 2,4-D-ring-UL-^{14}C moiety was converted into 2,4-DB in both species. The metabolism of 2,4-D in buckhorn plantain appeared to be twice that occurring in curly dock. This represented about 20% of the total quantity of freely extractable 2,4-D absorbed in buckhorn plantain and 10% in curly dock. Therefore, the major difference between the species was the four to six fold increased metabolism of 2,4-DB to 2,4-D in curly dock over buckhorn plantain.

Techniques used for extracting and identifying total lipids revealed a major difference which could explain the metabolism differences. Thin layer techniques which separated neutral lipids from polar lipids yielded large quantities of label remaining at the origin where phospholipids and glycolipids would be present (Table 3). The quantities were approximately 10 times higher in buckhorn plantain than in curly dock extracts. In most subsequent experiments two to six fold differences were noted. The levels formed were dependent on incubation time, lighting, temperature, and other experimental conditions. Fractionation of the neutral and polar lipids and the use of two-dimensional chromatography on the polar lipid fraction yielded labeled phospholipids and no labeled glycolipids. Hydrolysis with 1N HCl at 95 to 100°*C* over night resulted primarily in 2,4-DB and very low levels of 2,4-D and other metabolites. Thus 2,4-DB (and 2,4-D) was able to complex with phospholipids. However, only after 10 hours incubation was the difference substantial enough to possibly explain susceptibility differences between the two species (Table 3). Low quantities of phospholipids seemed to be involved for mole ratios of label bound to phosphate in the lipid fraction per gram fresh weight were 0.0005 in curly dock and 0.0012 in buckhorn plantain following a four hour incubation with 2,4-DB. The amounts of phospholipids per gram fresh or dry weight were equivalent in both species. The complex appeared to be less stable in curly dock. Greater levels of the phospholipid complex were isolated from the treated leaves of intact buckhorn plantain plants as well. Approximately four times as much complex, representing 25% of the label present in the treated leaves, was recovered from buckhorn plantain compared to curly dock 72 hours after treatment (Table 5). The quantity of complex formed increased with time in buckhorn plantain and decreased in curly dock.

The formation of a phospholipid complex appeared to explain how species with similar respiratory rates and capabilities differed in selectivity. Apparently less 2,4-DB is available for beta oxidation in buckhorn plantain due to the formation of a stable complex. Presently other studies are in progress to further characterize the phospholipid cmplex type of mechanism of selectivity.

Table 1. Total absorption of 2,4-DB by intact curly dock (CD) and buckhorn plantain (BP) plants following a foliar treatment.

				Total absorption			
				(per plant basis)		(per gram fresh weight basis)	
Chemical applied	Analysis included	Species	Treatment time (hours)	dpm/plant	CD/BP ratio	nM/g fr wt	CD/BP ratio
2,4-DB-1-$^{14}C^{a}$	Labeled tissue plus $_{14}CO_2$	Curly dock	84	207,000	1.1	6.78	0.3
"	"	Buckhorn plantain	84	189,000	....	21.97	....
2,4-DB-ring-UL-$^{14}C^{b}$	Labeled tissue plus exudate	Curly dock	72	50,400	1.4	4.37	0.7
"	"	Buckhorn plantain[c]	72	37,000	....	6.52	....

[a]Average based on 8 replications.
[b]Averages based on 4 replications.
[c]Necrotic spots occurred on buckhorn plantain leaves within 1 hour after application.

Table 2. Distribution of label in curly dock and buckhorn plantain plants treated with 2,4-DB-ring-UL-^{14}C and grown in 0.5X Hoagland's solution.

		Percent label distribution[a] Incubation time (hours)	
Species	Plant Fraction	12	72
Curly dock	Treated leaf	93.4	26.8
	Other leaves	1.2	8.9
	Roots	5.3	60.0
	Exudation into 0.5X Hoagland's solution	0.1	4.3
Buckhorn plantain	Treated leaf	95.0	77.4
	Other leaves	0.3	4.6
	Roots	4.7	13.4
	Exudation into 0.5X Hoagland's solution	0.0	4.6

[a]Percentages based on nM/g fr wt.

Table 3. Distribution of label absorbed and released from leaf slices of curly dock and buckhorn plantain treated with 10^{-6}M 2, 4-DB-ring-UL-^{14}C.

Species	Incubation time (hours)	Total absorption (nM/g fr wt)	Percent label distribution: Tissue free 2,4-DB	Total free 2,5-D	Total free unknown compounds	Complex at origin
Curly dock	1	77.07	69	15	13	3
	4	89.15	48	31	15	6
	10	107.29	13	64	12	11
Buckhorn plantain	1	96.31	77	7	10	6
	4	155.98	64	13	12	11
	10	200.45	19	15	9	57

Table 4. Malonate inhibition of 2,4-DB-1-^{14}C respiration to $^{14}CO_2$ by curly dock and buckhorn plantain tissue slices.[a]

Species	Percent inhibition of $^{14}CO_2$ respiration: 0.4M	0.04M	0.004M
Curly dock	87-100	81-89	27-58
Buckhorn plantain	87-100	85-94	37-72

[a]Incubation times were varied from 1 to 20 hours at all the inhibitor concentrations.

Tble 5. The quantity of phospholipid complex formed in treated leaves of intact curly dock and buckhorn plantain plants after a 2,4-DB-ring-UL-^{14}C treatment.

Species	Hours after treatment	Quantity present in treated leaf (nM/g fr wt)	Quantity present as phospholipid complex (nM/g fr wt)
Curly dock	12	5.60	1.18
	72	1.17	0.30
Buckhorn plantain	12	5.52	0.65
	72	5.04	1.19

Absorption and Site of Action of a Pyridazinone Herbicide in Grain Sorghum Seed

Lawrence A. Romney and J. W. Whitworth[1]

An experimental herbicide, 4-chloro-5-(dimethylamino)-2-(alpha, alpha, alpha-trifluoro-*m*-tolyl)-3 (2H)-pyridazinone (S-6706) was studied to determine adsorption characteristics into seed and to gain an insight into the initial site of action.

When grain sorghum seeds soaked in a 5 ppm solution of the herbicide for 24 hours were transferred to sand flats in the greenhouse, the seedlings which emerged were so white and devoid of chlorophyll that they died within a short time. Cellular constituents isolated by centrifugation from extracts of seeds treated with C^{14} labeled S-6706 showed association of radioactivity with certain of the various cell fractions. In all cases, the greatest amount of radioactivity was found in the supernatant fraction (105,000xg for 2 hr). When this fraction was subjected to polyacrylamide disc gel electrophoresis, only one out of the several protein bands stained with a general protein stain showed radioactivity.

Further attempts were made to discover and characterize herbicide-induced changes in this supernatant fraction by staining the gels with specific stains for dehydrogenases and peroxidases. Differences observed in banding were primarily those of more rapid develepoment and intensity and not of position. These differences could have been associated with the observation that the seeds soaked in the herbicide solution, as compared to those soaked in water, germinated and emerged faster than seeds soaked in the herbicide.

The work so far would indicate a block in the early development of carotenoids which are essential for the protection of chlorophyll and chloroplast structure.

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Foliar Absorption Patterns in Creosotebush, Granjeno, Mesquite, and Other Desert Plants[1]

Herbert M. Hull and Howard L. Morton[2]

The technique of studying foliar penetration and translocation of fluorescent dyes under a microscope illuminated with incident ultraviolet light has been used for creosotebush [*Larrea tridentata* (DC.) Coville], granjeno (*Celtis pallada* Torr.), velvet mequite [*Prosopis juliflora* (Swartz) DC. var. *velutina* (Woot.) Sarg.], and other desert plants. Dyes can be chosen which possess chemical and physical properties closely matching those of certain selected herbicides, thus enabling evaluation of such additional factors as surfactant type and concentration, pH, and leaf maturity.

Although the finer leaf veins of many species are not visible with incident ultraviolet illumination, simultaneous transillumination with red light clearly depicts such veins since red light is absorbed by the chlorophyll in adjacent mesophyll tissue. With such illumination it becomes evident that the size, orientation, and density of trichomes and stomata immediately above the veins are different than in the interveinal areas. In some species, such as woolly tidestromia [*Tidestromia lanuginosa* (Nutt.) Standl.], trichomes uniformly cover the entire leaf surface. However, following dye absorption and depending upon species and degree of leaf maturity, these apparently uniform trichomes are seen to fluoresce irregularly in different degrees of intensity and varius hues. If the leaf is also transilluminated with red it may then be seen that the fluorescence pattern is indeed not irregular but is associated with the fine reticulate network of veins. Differences in stomatal and trichome absorption above veins as compared to interveinal areas appears to be a complex function of dye formulation, leaf maturity, and plant species.

In field mesquite, dye penetration occurs initially thrugh both trichomes and stomata. However, as the leaf matures the trichomes become increasingly cuticularized and their ability to serve as absorptive pathways is diminished. Thus, the entry of a dye by stomatal or direct cuticular penetration is the only alternative. Since greenhouse or chamber-grown mesquite leaves do not generally have trichomes on their surfaces, but only on their margins, such studies must be made on field material. We are currently observing the cross section and surface cuticular ultrastructure of indoor and outdoor mesquite leaves in order to correlate structure with seasonal changes in absorptive patterns.

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Herbicidal Action of MON-0573 as Influenced by Light and Soil

R. P. Upchurch and D. D. Baird[1]

Derivatives of *N*-(phosphonomethyl) glycine (MON-0573) have been shown to be effective postemergence herbicides (1) and specific presentations have been made on the response of quackgrass (2) and johnsongrass (3). The compounds are systemic in nature and are effective on a wide range of narrowleaf and broadleaf weed species. Under field conditions

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specimens of annual weeds are commonly eliminated at rates below 1 lb/A whereas specimens of perennial weeds are usually eliminated at rates below 2 lb/A. The influence of temperature and diluent properties on the performance of these compounds has been presented elsewhere (4). The purpose of the studies reported upon herein is to reveal additional information on the influence of light on the performance of this new herbicidal class and to reveal additional information on the behavior of a member of the class as influenced by soil. The dimethylamine salt of *N*-(phophonomethyl)glycine (MON-0468) was used in these studies.

Experiment I.
Influence of Light Intensity and Day Length

Johnsongrass plants were established from rhizomes in 4-inch by 4-inch plastic pots using Ray silt loam soil. After about three weeks of growth under greenhouse conditions, the plants were treated with a range of rates of MON-0468 using an aqueous spray volume of 20 gpa containing 10 g ai/L of Activate 107 surfactant. After treatment the plants were placed in growth chambers at 90 and 60 F and light intensities of 2000 and 500 foot candles, the latter being produced by the use of 63% grade Saran cloth at 12 inches above the plant foliage. After two weks in the growth chambers, responses were estimated visually and the treatments for the 90 F part of the study were all moved to a greenhouse where they were maintained under conditions of moderate sunshine and evaluated again after one week of exposure in the greenhouse. The treatments were duplicated and the 90 F phase of the experiment was repeated.

At two weeks after a postemergence treatment with *N*-(phosphonomethyl) glycine, johnsongrass plants were controlled more effectively under 2000 foot candles of light than under 500 foot candles whether exposed at 90 or at 60 F. After a further week of exposure of plants from the two levels of light intensity under moderate conditions of sunshine in the greenhouse, there was little or no difference in the control produced as a result of the original light conditions. Photoperiods of 8 and 14 hours had no influence on the activity of MON-0468 applied as a postemergence treatment. Plants exposed at 60 F for two weeks after treatment were more responsive to the herbicide than those exposed at 90 F.

Experiment II.
Influence of Shading Under Field Conditions

Plots of well established Kentucky bluegrass 6.7 x 50 feet in size were treated with a range of rates of MON-0468 under field conditions on May 14 at St. Charles, Missouri. In the aqueous spray volume of 30 gpa, Activate 107 surfactant was used at 10 g ai/L. Inside each plot degrees of shading were introduced on subplots within ten minutes after treatment by using one or three layers of 63 percent grade Saran cloth suspended at seven inches above the plant foliage. The single layer of cloth provided shading which reduced the light intensity by about one-third while three layers reduced light intensity by about two-thirds. The shaded and nonshaded subplots were 4 by 4 feet and the whole plots were replicated three times. Visual estimates of percent control were made at 21 and 35 days after treatment. The 35 day evaluation was made early in the morning immediately after removing the shading cloth. A third observation was recorded 24 hours after the cloth was removed.

At 21 days after treatment a 1 lb/A application of MON-0468 produced 95 percent control of bluegrass whereas substantially less control was achieved under either of the shading regimes (Table 2). During the next two weeks the herbicide continued to exert its action and the control percentage was increased appreciably under the one-third shading treatment. However, even at the 35 day evaluation period activity was reduced under shading as compared to nonshading conditions. When the shade was removed at the 35th day there was a dramatic increase in activity of the herbicide during the day and on the 36th day, control of bluegrass was substantially the same regardless of the prior conditions of shading.

Experiment III.
Preemergence Activity of MON-0468 Under Greenhouse Conditions

Corn, wheat and soybeans were seeded at a depth of ½ inch in Ray silt loam soil contained in 4-inch by 4-inch plastic pots. MON-0468 was applied to the soil surface at a range of rates using an aqueous spray volume of 20 gpa and a concentration of 10 g ai/L of surfactant Activate 107. Following the herbicidal application, one series of pots was treated with ¼ inch of overhead simulated rainfall and a second series was subirrigated. The pots were maintained in the greenhouse with subirrigation as required for 42 days at which time a visual estimate of preemergence activity was recorded. Three replications were used.

More than 32 lb/A of MON-0468 was required to produce any symptoms of plant injury in the case of the simulated rainfall treatments and more than 8 lb/A was required in the case of the subirrigated treatments (Table 3). Under these conditions about ½ lb/A of MON-0468 is adequate to insure control of such species as johnsongrass and quackgrass. One concludes that crops planted after use of MON-0573 in the field will be unlikely to suffer due to the preemergence activity of this herbicide. The method of initial irrigation had little influence on the preemergence activity of MON-0468 nor were the three species tested dramatically different in their respense to the herbicide as applied.

Experiment IV.

Influence of Treated Vegetation on Expression of MON-0468 Activity in Soil Under Greenhouse Conditions

Johnsongrass and quackgrass plants were established from rhizomes in Ray silt loam soil contained in 4-inch by 4-inch plastic pots. At three weeks of age the plants were treated with a range of rates of MON-0468 using an aqueous spray volume of 20 gpa. The spray solutions contained 10 g ai/L of surfactant Activate 107. Two replications were used. At two weeks after treatment the dead or living foliage, the top ½ inch layer of soil and plant material contained therein were removed and ground in a Waring blender. Corn, soybeans, wheat and alfalfa seed were placed in the original containers and covered by the blended materials. Three weeks after the crops were planted, a visual estimate was made of the percent control of the crop species.

None of the plant species used to test residual preemergence herbicidal activity exhibited any symptoms of injury where the original rates of MON-0468 application had been 2, 4 or 8 lb/A, the latter being the highest rate used. In this test, there was no demonstration that a preemergence herbicidal effect can be enhanced by incorporating into soil plant material killed by application of foliar treatments of MON-0468.

General Observations

Although light intensity has a significant influence on the response of plants to the *N*-(phosphonomethyl) glycines, it appears that the net result is to attenuate the rate at which the compound achieves its ultimate effect. This observation should help to explain the rate of action of this class of herbicides as members are applied under diverse light conditions. The results presented on preemergence activity reinforce the conclusion previously reached that the *N*-(phosphonomethyl)glycines do not exhibit preemergence herbicidal action at rates required for the control of a wide variety of weed species.

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Table 1. Influence of light intensity photoperiod and temperature on the response of johnsongrass to MON-0468.

		Percent Control			
		After Two Weeks Exposure at 90 F		After Two Weeks Exposure at 60 F	
MON-0468 lb/A	Light Intensity	8 hr. Photoperiod	14 hr. Photoperiod	8 hr. Photoperiod	14 hr. Photoperiod
1/2	2000 fc	94 (100)*	98 (99)	100	100
1/4	"	87 (92)	88 (96)	100	100
1/8	"	50 (58)	51 (52)	100	100
1/16	"	8 (10)	18 (11)	93	90
1/32	"	0 (0)	0 (0)	10	15
1/2	500 fc	81 (98)	72 (100)	100	100
1/4	"	45 (82)	62 (94)	100	100
1/8	"	12 (35)	36 (55)	100	95
1/16	"	0 (0)	5 (15)	55	60
1/32	"	0 (0)	0 (0)	0	0

*Estimated % control after exposure for one further week in the greenhouse.

Table 2. Influence of Shading on the Response of Kentucky Bluegrass to MON-0468.

MON-0468 Lb/A	Amount of Shade	Percent Control 21 Days After Treatment	35 Days After Treatment	36 Days After Treatment
1.5	0	96	100	100
1.0	0	95	92	94
0.5	0	40	60	63
1.5	1/3	40*	72**	99
1.0	"	37*	62**	95
0.5	"	0*	32**	60
1.5	2/3	25*	58**	90
1.0	"	30*	35**	90
0.5	"	10*	23**	77

*Based on inspection of shaded areas from side views.

**Based on evaluations made within 20 minutes after permanent removal of shading materials.

Table 3. Preemergence Activity of MON-0468 on three Plant Species Under Greenhouse Conditions.

MON-0468 lb/A	Method of Initial Irrigation	Percent Control Corn	Wheat	Soybean
96	Subirrigation	55	87	23
64	"	37	42	17
32	"	9	27	0
16	"	0	5	0
8	"	0	0	0
4	"	0	0	0
96	Simulated Rainfall	22	65	75
64	"	5	19	0
32	"	0	0	0
16	"	0	0	0
8	"	0	0	0
4	"	0	0	0

Root Control in Relations to the Problem in Sewers and Drains

O. A. Leonard, D. E. Bayer, and R. K. Glenn[1]

sewers have continued, with several objectives, including (1) new chemicals which might be used, (2) health of treated roots at time of treatment on injury to shoots with metham, (3) effect of metham and dichlobenil on photosynthesis and transport of labeled assimilates. Most of these studies were conducted upon *Eucalyptus camaldulensis*.

Several herbicides were applied to eucalyptus roots at 10 and 100 ppm for 1 hour. Readings on root and shoot injury were recorded 5 weeks later following treatment. It may be noted in the table that picloram was the only herbicide tested that completely killed the portion of the root system that was treated. However, the appearance of appreciable injury to the shoots would rule this material out for general use. Paraquat and diquat did have an appreciable effect on the roots; however, killing was confined to those roots of less than 2 mm diameter. Some of the other materials killed only the very fine roots and/or caused stubby roots to form. Of the herbicides studied only 2 were effective for root control following a 1 hour soak—metham and dichlobenil (many studies). Metham may be regarded as the general killer of roots, while dichlobenil is a supplement to retard regrowth.

Injury to shoots from metham treatment occasionally occurs in the field. A mulberry injured from a 5,000

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Studies on the selective control of tree roots in ppm treatment for 1 hour in July 1969 in Sacramento County had essentially recovered in 2 years. Although the occurrence of injury in the field is relatively rare, we thought that root health at the time of treatment might be a factor affecting root injury. Eucalyptus roots were treated for 1 minute with 2,000 and 10,000 ppm metham and 1 hour with 100 ppm dichlobenil. Four weeks later these same roots were treated for 1 and 24 hours with 2,000 ppm metham. Out of 40 trees treated, only 6 showed evidence of shoot injury and 5 out of 6 had roots (part of root system previously treated with metham or dichlobenil) that were either dead or about dead at the time of treatment. The test was repeated using a concentration of 10,000 ppm metham for 24 hours. Only 2 plants developed shoot injury; on one of these; metham was applied to live roots and to the others, dead roots. These tests indicate that there probably is no appreciable difference in shoot injury, whether the treated roots are alive or dead at the time of treatment. Previous tests as well as those in the current study did show that the transfer of toxicity was through the roots, since removal of the roots below the pots before treatment resulted in no case of shoot injury.

A test was conducted to determine the effect of root treatment with 2,000 ppm metham or 100 ppm dichlobenil for 1 hour on photosynthesis and transport of assimilates in eucalyptus. The results of this study suggest that photosynthesis is not affected and that transport out of the leaves and into the plant is not affected except in those areas injured or killed by the treatment. With dichlobenil, there was an enhanced accumulation of assimilates in the treated part of the tap root. However, this affect soon disappeared (after 7 days); 4 to 6 weeks was required for the treated part of the root system to die with dichlobenil. The effect of metham seemed complete in 24 hours.

Effect of partial root treatment on injury to the treated roots and shoots.

	5 weeks after treatment Concentration (ppm)			
	10		100	
Herbicide	Shoots[1]	Treated roots	Shoots	Treated roots
Paraquat	0	1	0	5
Diquat	0	0	0	5
Bromocil	0	0	0	0
Cacodylic acid[2]	0	0	0	0
MSMA[2]	0	0	0	0
2,4,5-T amine	0	0	0	2
Picloram	0	8	5	10
MER-6023	0	0	0	0
CF-125	0	1	0	2
RP-17623	0	0	0	0
Eli-119	0	0	0	1
R-7465	0	0	0	1
CGA-10832	0	0	0	1

[1]Evaluation based on a 0 to 10 scale. 0 meant no effect and 10 = complete kill.
[2]These 2 materials were also treated at 1000 ppm. The cacodylic acid gave a rating of 4 to the roots and the MSMA 0, while the shoots were both 0. Controls were 0.
Eucalyptus camaldulensis roots were soaked for 1 hr.

Weed Control and Drift Reduction with the DIRECTA-SPRA[1] Roadside Sprayer

R. R. Johnson and R. J. Messinger[2]

Abstract. Applications of water-soluble amines, oil-soluble amines and low-volatile esters of 2,4-dichlorophenoxy acetic acid (2,4-D) at 2 lb/A were made through a DIRECTA-SPRA rotating nozzle roadside sprayer and a DOC-72 broadcast nozzle. Goldenrod, (*Solidago* spp.), heath aster, (*Aster ericoides*), wild carrot, (*Daucus carota*) and other weeds were controlled.

2,4-D oil soluble amine and 2,4-D low-volatile ester controlled weeds better than 2,4-D water-soluble amine. 2,4-D oil-soluble amine applied through the DIRECTA-SPRA was more effective than when applied through a DOC-72 broadcast nozzle.

[1]Registered trademark of Amchem Products, Inc., Ambler, Pa. 19002.
[2]Research and Development Dept., Agricultural Chemical Div., Amchem Products, Inc., Ambler, Pa. 19002.

Calibration studies indicate that a herbicide mixture rather than water should be used for calibrating the DIRECTA-SPRA since swath width is greater with water than with most herbicide solutions or emulsions.

A drift study using snapbeans (*Phaseolus vulgaris* 'Black Valentine'), as bioassay plants showed no biological evidence of drift beyond 50 feet from the downwind edge of the spray swath. Winds during the study blew directly across the spray swath at velocities of 6 to 18 mph. There was negligible spray drift more than 15 feet downwind from the DIRECTA-SPRA with tips in place or 10 feet downwind with the tips removed.

Introduction

Using various salts and esters of 2,4-D to control broadleaf weeds along highway, utility and railroad rights-of-way has been an established practice since soon after the introduction of 2,4-D in the 1940's. Unfortunately, 2,4-D injury to susceptible plants adjacent to the rights-of-way made it impossible to use 2,4-D in many areas and required great caution in most other areas. Invert emulsions, particulating agents and thickeners have been mixed with herbicide solutions and emulsions to increase the spray mixture viscosity. Larger droplets are formed and the number of fine particles is reduced. As a result, drift away from the sprayed area is reduced. However, preparing or mixing viscosity-increasing agents is usually complex or time-consuming.

Through a rotating nozzle the DIRECTA-SPRA roadside sprayer applies a conventional herbicide solution or emulsion over a 20 to 30 foot swath at 30 psi. With different inserts, it sprays sectors of 90° and 180°, so it can be mounted directly on the side of a spray vehicle. The spray unit is equipped with removable tips which break up the spray stream to make smaller droplets and increase coverage. Removing the tips will also increase the swath width.

The objectives of this study, conducted near Spring house, Pa., were to determine the weed control obtained with various salts and an ester of 2,4-D applied with the DIRECTA-SPRA and to determine the extent of drift control. Snapbeans (*Phaseolus vulgaris* 'Black *Valentine*') were used for a bioassay test.

Materials and Methods

A DIRECTA-SPRA unit was mounted on a 4-wheel drive jeep equipped with a 5-horsepower centrifugal pump. The spray head was mounted 4 feet high on the right side of the vehicle and inclined at an angle of 20° to give maximum swath width.

In the performance study dimethylamine salt, butoxyethanol ester and mixed dodecyl and tetradecylamine salts (oil soluble amines) of 2,4-D were applied to 50 x 300 foot plots at the rate of 2 lb/A in 30 gallons of water. Treatments were replicated twice. A DOC-72[1] nozzle was included for comparison. All treatments were applied at a vehicle speed of 10 mph. Applications were made on August 18, 1971, when the three weeds rated were in early bloom stage.

Visual estimates of percent weed control were made on three species: goldenrod (*Solidago* spp.), heath aster (*Aster ericoides*), and wild carrot (*Daucus carota*) on October 7, 1971. Effective swath width was measured at this time.

During the drift study the DIRECTA-SPRA unit was operated at 30 psi. The spray vehicle was driven at 10 mph. Cross winds during the study varied from 6 to 16 mph. Four runs were made with the nozzle tips in place and three with them removed. The nozzle unit was rotated at 72 rpm throughout the study. In two consecutive runs with nearly equal wind conditions clockwise and counter-clockwise rotation were compared. To determine drift control, bean plants were set out at measured distances downwind from the spray nozzle. Variations on the method described by Laning and Holmsen were used (1). Bioasay stations were established at 0, 25, 30, 35, 40, 45, 50, 100, 200 and 400 feet downwind from the spray nozzle and at 25 feet upwind. Stations were elevated 8 inches from ground level on concrete blocks. At the 50 foot station beans were placed at the 8 inch level and on a platform 8 feet from the ground. The jeep-mounted sprayer was driven 800 feet on a road perpendicular to the bioassay stations. Runs, made when winds were greater than 6 mph, were not more than 45° from parallel with the bioassay line. A roll of adding machine paper was used to delineate the actual spray swath.

Snapbeans were grown in 3 inch plastic pots in the greenhouse for five to seven days, hardened off for two days under lath outdoors, and placed on the stations prior to each spray run. Three bean plants were placed at each station in the swath area and five at each station from 50 to 400 feet. Clean paper plates were placed under the bean plants for each run. Five minutes after each run, the bean plants were collected in plastic trays which were constructed to prevent the leaves from touching each other. Beans remained in these trays during the two-week observation period. Check plants were placed in the greenhouse and in the upwind activity area to detect contamination from sources other than drift.

An epinasty evaluation was made after 24 hours using a 0 to 10 scale, with 1 being the least epinasty observable and 10 being a 180° bending of the main bean stem. After 14 to 21 days, when the second trifoliolate leaf was fully expanded, a second evaluation was made. Ratings on a 0 to 10 scale ranged from a 1 for the least observable epinasty or leaf-strapping to

[1]Manufactured by Spraying Systems Company, Bellwood, Illinois 60104.

a 10 for death of the terminal bud. At this time, fresh weight of the growth of each plant subsequent to spraying was recorded.

Results and Discussion

Weed control results from the DIRECTA-SPRA treatments indicated that 2,4-D oil soluble amine and 2,4-D butoxyethanol ester controlled weeds better than did 2,4-D dimethylamine. Weed control ratings after 50 days were: 2,4-D dimethylamine, 62 percent, oil-soluble amine, 79% and butoxyethanol ester, 80 percent.

In a comparison of the weed control with and without spray tips using 2,4-D oil-soluble amine, weed control was similar whether or not they were used. The nozzle with tips gave 72 percent weed control and without tips 79 percent. The DOC-72 broadcast nozzle gave 55 percent weed control. It is hypothesized that the improved weed control with the DIRECTA-SPRA, compared to that with the DOC nozzle, results from the multi-directional coverage obtained from a rotary nozzle instead of one-sided coverage with a stationary nozzle.

Calibration studies indicated that DIRECTA-SPRA delivery rates and swath widths differ with water and spray emulsions. It is important, therefore, to do final calibration work with the formulation which will be sprayed.

Examination of the three methods of evaluation used in the drift study showed that the 24-hour epinasty observation gave the most sensitive indication to drift. This reading was readily taken, did not require greenhouse space for as long, and was less subject to external variables such as hand watering, soil temperature, ambient air temperature, or light intensity.

Twenty-four hour epinasty evaluations for four runs of the DIRECTA-SPRA with tips in place and three runs with tips removed were averaged separately. Results are shown in Figure 1. Ratings at all stations were calculated from the downwind edge of the spray swath as determined from the paper strip used for each run. Injury was measured by epinasty of snapbean stems 24 hours after exposure to 2,4-D drift.

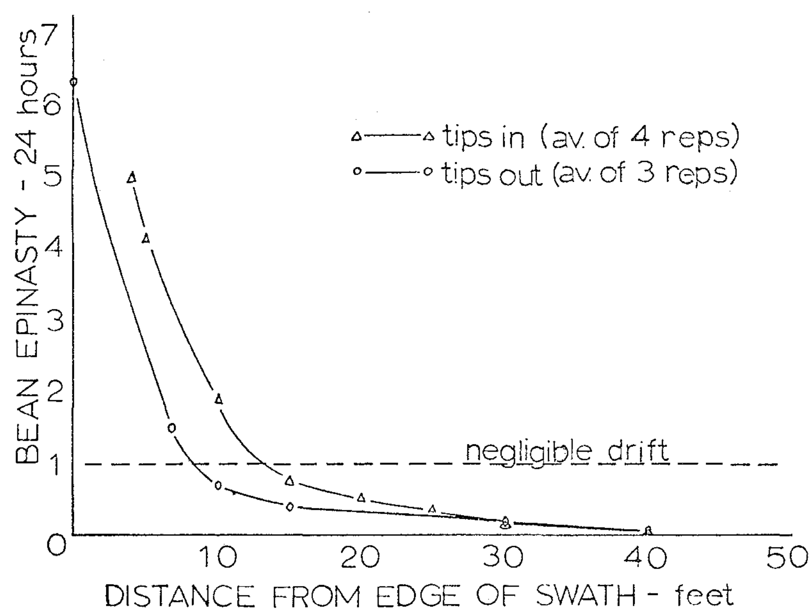
A reading of 1 on the epinasty scale represents the least observable drift effect. Assuming that a reading of 1 or less represents negligible drift, it would be unlikely that drift effects would be observed on sensitive plants more than 15 feet downwind from the DIRECTA-SPRA with tips in place or 10 feet downwind with tips removed.

A direct comparison of clockwise and counter-clockwise rotation of the spray unit with tips in place and with a wind perpendicular to the spray swath indicated that clockwise rotation produces less drift than counter-clockwise rotation. Clockwise rotation showed no significant drift injury beyond 7 feet downwind, while counter-clockwise rotation rotation showed injury to 22 feet under similar conditions.

Literature Cited

1. Laning, E. R. and T. W. Holmsen. 1969. Minimizing spray drift of herbicides. Industrial Vegetation Management. (Dow Chemical Co.) 1:2-5.

Figure 1. The influence of distance from the downwind edge of the spray swath on 2,4-D draft injury from the DIRECTA-SPRA roadside sprayer.



Fall-Spring Effects of Phenoxy Herbicides on Manzanita and Ponderosa Pine

H. Gratkowski[1]

Abstract. Correct timing of herbicidal sprays is necessary for successful release of young coniferous trees from brush competition in Pacific Northwest forests. This is especially important with ponderosa pine (*Pinus ponderosa* Laws.), which is very susceptible to damage from herbicides. Late summer sprays will safely release pines from many native shrub species, but manzanitas are resistant to herbicides in that season. An experiment was conducted to determine whether phenoxy herbicides will safely release ponderosa pines from manzanita during late winter, when manzanitas bloom but pines are still dormant.

Propylene glycol butyl ether esters of 2,4-D and 2,4,5-T were applied separately in water and in oil-in-water emulsion on ponderosa pines beginning in late November and then periodically until mid-May, when the pines began their spring flush of growth. The trees ranged from 3 to 7 feet in height at time of treatment. Manzanitas were treated with 2 aehg 2,4-D in an emulsion carrier. Phenological observations on manzanita were used to indicate timing.

Manzanitas were killed throughout the entire period from late November until mid-May. In contrast, pines were not susceptible to the herbicides until the first flowers bloomed on manzanita, but they became progressively more susceptible after that. Results of the study indicate that aerial sprays can be used to release young ponderosa pines from manzanita during late winter. It may even be safe to apply low volume aerial sprays until manzanita is in full bloom, but this will have to be determined in small aerial spray trials.

Pines became susceptible to the phenoxy herbicides 2½ months before their buds began to swell in the first visible sign of the spring flush of growth. This knowledge is important to foresters, who have often considered dormancy synonymous with resistance to herbicides. It also helps to explain the erratic and frequently extensive damage to ponderosa pines in early spring applications of herbicidal sprays.

[1]Pacific N.W. Forest and Range Expt. Sta., Forest Service, U.S. Dept. of Agric., Roseburg, Oregon 97470.

Foliage Applied Herbicides for Control of Oregon Coast Range Brush Species

R. E. Stewart[1]

Abstract. During the 1970 growing season, several herbicides and combinations of herbicides were screened as foliage sprays on six major brush species in the Oregon Coast Range. Red alder, salmonberry, western thimbleberry, vine maple, California hazel, and salal compete with young conifers and reduce seedling survival and growth. Combinations of these species also form extensive brushfields on high site forest lands.

The herbicides were applied in water or in oil-in-water carriers in late spring or midsummer using knapsack sprayers. Individual plants of all species except salal were treated to drip point. Herbicides were applied to 1/1000-acre plots of salal. The following herbicides or herbicide combinations were tested on one or more species.

1. 2,4-D
2. 2,4,5-T
3. Silvex
4. MSMA
5. Dicamba
6. Amitrole-T
7. Picloram
8. Bromacil
9. MSMA + 2,4-D
10. MSMA + 2,4,5-T
11. MSMA + amitrole-T
12. Dicamba + 2,4-D
13. Dicamba + 2,4,5-T
14. 2,4-D + dichlorprop
15. 2,4-D + dichlorprop + 2,3,6-TBA

Topkill and number and size of resprouts were measured during September of 1971. Late spring applications of picloram at 1 lb aehg were effective on all species. Late spring and midsummer applications of 1 lb aehg 2,4-D or 2,4,5-T killed red alder. Late spring or midsummer treatments of 3 lb aehg 2,4,5-T in an oil-in-water emulsion were as effective as 3 lb aehg amitrole-T on salmonberry and more effective on western thimbleberry.

Late spring applications of 3 lb aehg 2,4,5-T or 2.2 lb MSMA + 1 lb 2,4,5-T produced good top control of vine maple, but best kill was obtained with 2 lb aehg of picloram. Excellent control of California hazel was obtained with late spring treatments of 3 lb aehg 2,4,5-T, 1 lb aehg picloram, or 1 lb 2,4-D + 1 lb dichlorprop. Of the nine herbicides and herbicide combinations tested on salal, only a late spring application of 1 lb per acre picloram provided an appreciable degree of control. This treatment reduced salal cover by 68 percent compared to untreated plots.

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Summary of A-820 Performance on Ornamental Turfgrasses

John E. Gallagher, John F. Koerwer, and James R. McKinley[1]

Introduction

The potential of N-secondary-butyl-4-tertiary-butyl-2, 6-dinitroaniline (A-820) for preemergence

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control of crabgrass (*Digitaria* spp.) became evident early in its investigation. The compound, discovered and field tested for various purposes by Amchem Products, Inc., has performed well as a preemergence herbicide and is tolerated satisfactorily by ornamental turf grasses. Results of test programs from 1969 through 1971 confirmed the initial findings, and a petition for label registration was submitted to EPA in October, 1971.

The first formulation used (Amchem 69-41, a 2 lb/gal emulsifiable liquid) produced good crabgrass control but injured turfgrass objectionably. During the 1970 field trials Amchem 70-25, an improved liquid formulation, and Amchem 70-123, a 4% vermiculite granular formulation, were used. These retained the excellent crabgrass control characteristic while providing three times as much safety.

Results in the 1970 test program indicated that for cool-season turfgrass regions the appropriate rate is 4 lb/A, and for warm-season grasses 6 lb/A. Normal germination of turfgrasses seeded the fall after spring application appeared probable. Encouraged by continued evidence of turfgrass tolerance, 1971 test programs were planned to provide further data needed for label registration. Amchem 70-314-B, a 2.3% vermiculite granular formulation designed to provide adequate volume for good coverage from standard spreaders, was determined as the most suitable form and was used in most of the 1971 field trials.

The 1971 tests provided response information for cool- and warm-season turfgrass species tolerance, rates needed for crabgrass control in differing regions, and data on controlling additional annual weed grasses which occasionally become lawn problems. Because of the greater importance of crabgrass in the Northeast and North Central part of the United States, more tests were established there. The South and Southwest were represented sufficiently to confirm the 6 lb/A rate for this area's warm-season turfgrasses.

Crabgrass Control

All tests compared A-820 with either DCPA at 10 lb/A (15 lb/A in the West) or benefin at 2 lb/A (3 lb/A in the West). There were five test locations in the Northeast. Rates applied varied from 2 to 10 lb/A. The 4 lb/A rate provided an average of 95% control. The Midwest had two locations (Indiana and Iowa); at the 4 lb/A rate control averaged 96%. In the South (Georgia, North Carolina and Tennessee) at the 4 lb/A rate control averaged 89%. In the single far West location (California), 6 lb/A was needed to produce 82% control. Data is summarized in Table 1.

Table 1. Regional summary of A-820[a] crabgrass control.

Herbicide	Rate lb/A	Northeast (5 locations)	North Central (2 locations)	South (3 locations)	Far West (1 location)
A-820	2.0	76 (3)[b]	92 (2)[b]		61 (1)[b]
A-820	3.0	68 (1)	93 (1)		
A-820	4.0	95 (4)	96 (2)	86 (3)	55 (1)
A-820	5.0	....	98 (1)		
A-820	6.0	97 (3)	99 (2)		82 (1)
A-820	8.0	98 (5)	99 (2)	100 (1)	
DCPA	10.0	96 (3)	94 (2)	93 (3)	
DCPA	15.0	....			80 (1)
benefin	2.0	92 (2)			
benefin	3.0	....		85 (2)	88 (1)

[a]Tested as Amchem 70-314-B, 2.3% vermiculite granular formulation.

[b]Number of tests in which rate was used.

[b]Number of tests in which rate was used.

Turfgrass Tolerance

Under the conditions of the 1971 field trials, A-820 tolerance by most common turfgrass species was excellent. Table 2 records the maximum injury by species regardless of the number of tests conducted. There was only one instance of injury to bentgrass in any of the spring-applied tests and it was slight. The single serious injury occurred in a fall test on a Penncross bentgrass fairway where excessive rainfall (6.65 inches within 11 days) kept the fairway saturated for two weeks. No other fall application for crabgrass control in 1970 or 1971 produced any injury. Most cool-season grasses and the common turfgrasses of the South were included in the test program. In one test conducted on the Amchem Research Farm at Ambler, Pa., a combined fall and spring treatment totaling 16 lb/A provided excellent crabgrass control with no apparent effect on the mixture of common bluegrass, fineleaf fescue, and creeping bentgrass.

Turfgrass Seed Tolerance

In greenhouse trials, turfgrass seedlings were prevented from emerging up to 180 days when sterilized flats were treated at the 4 lb/A level. In a field test where the soil microbial population could be influential, the 4 lb/A rate allowed satisfactory germination of common bluegrass and Pennlawn red rescue 101 days following treatment, the time of fall seeding. In this same test, turfgrass seed germination in areas treated with 4 lb/A A-820 liquid or granular was equal to those treated with 1 to 2 lb/A benefin. All three materials controlled smooth crabgrass (*Digitaria ischaemum*).

In the previously mentioned fall and spring crabgrass control tests, May treatments of 0, 2, 4, 6 and 8 lb/A rates of A-820 were verticut and overseeded with a bluegrass/fescue mixture in August. Seedling counts were made two weeks later. Three 4" plugs were randomly removed from each of the six replications. Counts from these 18 plugs per treatment provided the averages presented in Table 3. The figures indicate successful fall overseeding of spring-treated turf at rates from 0 to 8 lb/A. All treated plots showed a greater stand establishment than the check, indicating that weed competition was more of a factor than chemical inhibition.

Table 2. Summarized turfgrass tolerance of A-820.

Species	Highest rate tested	Lb/A causing injury	Injury rating[a]
Cool-season grases:			
Bentgrass, Highland Colonial	12 lb/A	None	0
Bentgrass, Penncross	12	None	0
Bentgrass, red top	6	4, 6	2
Bentgrass, Seaside	12	12	Trace
Bluegrass, common Kentucky	12	None	0
Bluegrass, Merion Kentucky	12	None	0
Fescue, fineleaf	12	8	Trace
Fescue, K-31 tall	12	None	0
Fescue, Pennlawn	12	4	Trace
Warm-season grasses:			
Bahia, Argentina	8	None	0
Bahia, Pennsacola	8	None	0
Bermudagrass. common	8	None	0
Bermudagrass, Tif 419	8	None	0
Bermudagrass, Tifdwarf	12	None	0
Bermudagrass, Tifgreen	8	None	0
Bermudagrass, Tifway	12	None	0
Centipedegrass	12	None	0
St. Augustine, Bitter Blue	8	None	0
St. Augustine, common	12	None	0
St. Augustine, Scott's 1081	8	None	0
Zoysia, Meyer	12	None	0

[a] 0 = no injury, 10 = complete kill

Control of Annual Grasses Other Than Digitaria spp.

In greenhouse persistence studies using Amchem 70-314-B and another experimental granular formulation of A820, yellow foxtail (*Setaria lutescens*) and silver crabgrass (*Eleusine indica*) in flats of unsterilized soil treated at the 4 lb/A rate were prevented from emerging up to 120 days.

In field tests at the Amchem Research Farm, Clinton, Iowa, plants of three weed grasses were counted: crabgrass, barnyardgrass (*Echinochloa crusgalli*) and witchgrass (*Panicum capillare*). Rates of 0, 2, 4, 6 and 8 lb/A Amchem 70-314-B were used; 10 lb/A DCPA was the standard for comparison. All A-820 treatments were more effective on all species than the 10 lb/A DCPA treatment (Table 4).

Table 3. Response of fall turfgrass seeding[a] in lawns previously treated with A-820 (Amchem 70-314-B). Amchem Research Farm, Ambler, Pa.

Treatment date	Rate lb/A	Average number seedlings/4" plug[b]
October 28, 1970	8	25
May 7, 1971	0	15
May 7, 1971	2	19
May 7, 1971	4	18
May 7, 1971	6	33
May 7, 1971	8	24

[a]Plots overseeded August 19, 1971 with Kentucky bluegrass and fineleaf fescue.
[b]Three 4" plug samples each counted from 6 replications on September 2, 1971.

Table 4. Annual weed grass control with A-820 (Amchem 70-314-B). Amchem Research Farm, Clinton, Iowa.

Treatment	Rate lb/A	% Control Crabgrass	Barnyardgrass	Witchgrass
Check	0	0	0	0
A-820	2	94	68	25
A-820	4	95	75	43
A-820	6	99	75	53
A-820	8	99	94	82
DCPA	10	92	65	18

[a]Average of 4 replications; converted from number of crabgrass plants per plot. Treatments applied May 12, 1971; evaluated October 1.

Cooperators

Amchem acknowledges with appreciation the contributions of the following research workers whose data has been utilized in this report:

Dr. Lloyd M. Callahan, University of Tennessee, Knoxville, Tennessee 37901.

Dr. John F. Cornman, Cornell University, Ithaca, New York, and Herbert J. Kastyl, Nassau County Extension Service, Mineola, New York 11501.

Dr. William H. Daniel, Department of Agronomy, Purdue University, West Lafayette, Indiana 47907.

Dr. Joseph M. Duich, Department of Agronomy, The Pennsylvania State University, University Park, Pennsylvania 16802.

Dr. Clyde L. Elmore, Department of Botany, University of California, Davis, California 95616.

Dr. Ralph E. Engle, Department of Soils and Crops, Rutgers — The State University, New Brunswick, New Jersey 08903.

Mr. B. J. Johnson, Griffin Experiment Station, University of Georgia, Griffin, Georgia 30223.

Mr. John A. Jagschitz, Department of Plants and Soil Science, University of Rhode Island, Kingston, Rhode Island 02881.

Dr. William M. Lewis, Department of Weed Science, North Carolina State University, Raleigh, North Carolina 27607.

Control of Coarse-Leavel Grasses in Bluegrass Turf

Jess L. Fults[1]

This study, a progress report of which was reported in 1970, has been continued in 1971. The treatments made in 1970 were repeated on the same plots in 1971. It is concerned with the *selective* removal of coarse fescue (*Festuca arundinacea* Schreb.), orchard grass (*Dactylis glomerata* L.), red top (*Agrostis alba* L.), timothy (*Phleum pratense*), perennial ryegrass (*Lolium perenne* L.), and smooth bromegrass (*Bromus inermis Leyss.*) from Kentucky bluegrass (*Poa pratensis* L.) turf. In Experiment 1, seven different herbicides in *all possible paired* combinations have been studied for each coarse grass. These include the organic arsenicals (sodium cacodylate plus dimethyl arsenic acid) 1 pint/50 gal water/acre; MSMA +

[1]Weed Research Laboratory, Botany Department, Colorado State University, Fort Collins, Colorado 80521.

surfactant 5.4 pints/215 gal water/acre; amitrole 8 lb/86 gal water/acre; paraquat 1 lb ai/215 gal water/acre; potassium cyanate 30 lb ai/86 gal water/acre; dalapon 6 lb ai/86 gal water/acre and picloram 8 lb ai/86 gal water/acre. In Experiment 2, the same chemicals have been studied but each was used alone in combination with 4 levels of nitrogen fertilization (ammonium sulfate) 2, 4, 8 and 12 lb of "N"/1000 sq ft per year. Quantitative data on the effects of treatment were secured by making 3 one-square-foot quadrant occular estimates in each plot and treatment on July 23, 1971. The trends in 1971 were similar to those reported in 1970 in that each coarse grass responded differently. The arbitrarily selected 'best' treatments in Experiment 1 (paired herbicides) and Experiment 2 (single herbicides at 4 nitrogen levels) for the 6 coarse grasses are shown in the following table.

The selective removal of coarse grasses from Ken tucky bluegrass turf. 1971 evaluation. Fort Collins, Colorado.

The selective removal of coarse grasses from Kentucky bluegrass turf. 1971 evaluation. Fort Collins, Colorado.

Coarse grass	"Best" Treatment Experiment 1 (paired herbicides)	Experiment 2 (single herbicides + N)
1. Coarse fescue (**Festuca elatior**)	Paraquat + picloram 13 treatments reduced fescue to 0 percent	Sodium cacodylate + 8 lb N/1000 sq ft Plus dimethyl arsenic and 10 treatments reduced fescue to 0 percent
2. Orchard grass (**Dactylis glomerata**)	Sodium cacodylate plus dimethyl arsenic acid at single rate 18 treatments reduced orchard grass to 0 percent	Sodium cacodylate plus dimethyl arsenic acid + 4 lb N/1000 sq ft 3 treatments reduced orchard grass to 0 percent
3. Red Top (**Agrostis alba**)	MSMA + surfactant at single rate 25 treatments reduced red top to 0 percent	Potassium cyanate + 8 lb N/100 sq ft 24 treatments reduced red top to 0 percent
4. Timothy (**Phleum pratense**)	Potassium cyanate + MSMA ± surfactant 10 treatments reduced timothy to 0 percent	Potassium cyanate + 8 lb N/1000 sq ft 6 treatments reduced timothy to 0 percent
5. Perennial ryegrass (**Lolium perenne**)	MSMA + surfactant at single rate 14 treatments reduced perennial ryegrass to 0 percent	8 lb N/1000 sq ft 26 treatments reduced perennial ryegrass to 0 percent
6. Smooth bromegrass (**Bromus inermis**)	Sodium cacodylate plus dimethyl arsenic acid at 2X rate 56 treatments reduced bromegrass to 0 percent	MSMA + surfactant plus 2 lb N/1000 sq ft 12 lb N/1000 sq ft 31 treatments reduced bromegrass to 0 percent

Introductory Lecture to Weed Science

R. L. Zimdahl[1]

When a student signs up for chemistry or English he has a good idea of what to expect in the way of course content. He also has some idea of the relation of the subject to the world at large. I do not believe this is true of the beginning student in weed science. An introductory lecture in weed science should therefore try to tell the student the background development of the discipline of weed science, why it is important, some of what he will learn in the course and the relevance of the subject to agriculture and food production. My introductory lecture uses several slides in attempting to show the student the study of weed control and herbicides is a challenging and demanding task which requires diverse abilities and has made and will continue to make significant contributions to food production and our environment.

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Teaching Methods and/or Techniques To The Beginning Weed Science Student

Arnold P. Appleby[1]

I do not intend to give a formal speech here today, but I do want to take this opportunity to present some random thoughts for possible discussion. I will first discuss some methods and techniques in weed control courses specifically, and then mention a couple of ideas about college teaching in general.

For purposes of discussion, I will primarily base my remarks on techniques that we use at Oregon State, although I fully realize that we certainly do not have a monopoly on good teaching techniques. These are simply the ones that I am most familiar with. Hopefully, other good techniques will come out during the discussion period.

We tell our students that our weed control course is "practical". But by practical, we mean that the information hopefully will be useful 10 to 20 years from now and is not based on only those materials that are immediately available. Therefore, we spend a great deal of our time on *principles* and we use the current materials as examples to illustrate these principles. We emphasize the "*why*" rather than the "*what*". We do not say that EPTC is lost more readily from a wet soil surface than from a dry one and have them memorize that fact. But rather we talk about adsorption, competition of water for adsorption sites, etc.

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We have initiated a discussion period in our course this past year. The class is divided into sections to allow more informality and better exchange of views. It is in the discussion period where we may talk about control measures for specific problems. We bring in supplementary materials such as films and slides. We try hard not to exam the students on any information covered solely in the discussion period so that the students will not feel that they need to spend the discussion period taking notes.

We require a term project of all of our students. This may consist of a library paper, interviews with growers, commercial applicators or regulatory agencies, greenhouse research projects, or others.

We try to take several field trips during the term, usually during the laboratory period. Near the end of the course, we charter a bus on a Saturday and visit several good farmers in the area. We ask them to talk to us about their own weed control problems and practices. This unquestionably adds to the value of the course and makes the students realize really how much they have learned during the term.

I have some rather definite feelings about examinations. We do not give true-false questions, because I find it very difficult to come up with absolutely true statements in this day and age. I am sure that there are good true-false questions, but I am not smart enough to think them up. We do not give essay questions either, because it is too difficult to decide whether the student really knows the answer or whether he is merely good at regurgitating several pages of notes. We have primarily gone to short-answer questions in which directions are given to "answer the following questions in four sentences or less". We try to make the questions realistic. For example, we may have the student assume that he is a county agent and is answering a question on the telephone . The question represents a true-life situation and requires weed control knowledge to answer. In other words, we are trying to get the students' minds out of the notebook and into real-life. These questions have been successful, in my opinion, and have several advantages: (a) The teacher can read the answers at a glance and know immediately whether the student understands the situation. (b) The questions require thought rather than just memorization. (c) The questions show the students how facts learned in class can actually be used in a practical situation. (d) It provides the opportunity for alternative answers that the teacher may not have thought of.

Now let me throw out an idea or two on teaching in general. Our objective, as I see it, is to teach as much as we can to as many as we can, at least up to a certain minimum level. We know that all students are different, but we act like we don't know that. All students get the same lecture, the same reading assignments, the same examinations of the same period of time. But the idea that all students start the course at the same knowledge level and learn at the same rate is ridiculous.

If a student learns 60% of what is required by the end of the term, he flunks! He is told that he is a failure and is given a sheet of paper to prove it. Perhaps he didn't really fail, maybe he just simply didn't learn as fast as some others. Or maybe he started at a lower level than the rest of the class.

Perhaps we should not limit the time in which a student is required to obtain a minimum level of skill and knowledge as rigidly as we have in the past? If a person cannot reach that minimum level by the end of the term, give him an incomplete until he does. I am quite aware that there are many difficulties involved in this approach. This would interfere with the student's schedule, the teacher's schedule, procedures in the registrar's office, etc. But if we review our objectives, perhaps this would be a better approach for everyone. It would be better for the student because he does not fail and because he is allowed to reach at least a minimum level. It is better for the professor because he didn't *fail to teach* and he didn't waste time on a person who leaves his class with insufficient information to use it. It is better for the school and for society in general because our objective is to *teach*, not to classify people into "passers and failers".

This technique is being used by some universities and can be made successful. I believe it is time that we review our objectives and make sure our methods are designed to meet those objectives.

Single Course Exposure to Weed Control

K. C. Hamilton[1]

When Harry Agamalian invited us to participate in a Curriculum Symposium, the various topics he suggested involved two points of view. Applied vs. theoretic curricula. Visual aids vs. laboratory exercises. It is not difficult to see why one living in California would assume all states must have hordes of weed workers and such discussions would be common. This is part of the thinking that The Lord lives in California, and he must, for I believe his salary also has been frozen for the past years.

However, in one of the outer provinces of California, sometimes called Arizona, there is only one state weed worker teaching one weed science course. Under this condition, where one man and one weed course must instruct both undergraduates and graduate students in Weed Science there is little time for disagreement.

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Why do Students take the Weed Science Course?

Within our department some advisors suggest that students enroll. Students from other departments enroll *only* because other students refer them to the course. The number and proportion of graduate students in the course has steadily increased. The number of people in the course who are or will make a living in weed science or agricultural chemicals has also increased. Their participation in the class discussions has greatly improved the course.

What Can Be Covered in a Single Weed Science Course?

We attempt to teach weed identification in five field trips and four laboratory periods at the start of the semester. Discussion of how a given herbicide controls a given weed is more meaningful after the student has seen the weed. Sources of information on weed sciences are discussed and used, at least by the graduate students. The effects of weeds are discussed as are the various methods of weed control. Factors affecting soil and foliar applications are covered as are the characteristics of groups of herbicides and the most important herbicides in each group. We discuss principles involved in weed control and attempt to illustrate these with field examples from Arizona. Weed control in field crops, vegetables, tree crops, turf, urban areas, and range and how various weed control methods in these areas are integrated are discussed. If time allows, the legal problems involved in weed control are covered.

The course progresses from conventional given and parroting of facts to placing the student in field situations. No longer is he faced with a problem and a single answer but many answers from which he must chose the best. The final exams place the student in real farm, ranch, and business situations and he must discuss the problems he will face and how he will solve them.

The equipment to apply herbicides is covered in a single lecture and could be expanded to a full semester. This illustrates the greatest failing of a single weed science course. Time and the interest of the teacher cause many aspects of Weed Science to be neglected. In some area, an enthusiastic guest lecturer overcomes my shortcomings. We also try to correct the impression created by much of the faculty that the agricultural chemical industry and all industry is evil.

Selection of what to cover is the greatest problem, there are only 48 periods. A continual problem in teaching a single weed course is reducing the notes to the time available. Each year many new facts are added to the notes. This also means something must be dropped. Another problem is class discussion. In the early lectures the students are slow to enter the discussion. Later in the semester it may be difficult to control their interest and enthusiasm. Discussion after the lecture often is longer than the actual class. The lack of an appropriate text is another problem to which I have no answer.

In teaching a weed science course one can recruit students into the field of Weed Science. During the early and mid 1960's the weed course helped attract many students to the agriculture chemical industry. The course is now oriented more as a service course to people going into other phases of agriculture.

How Well Does a Single Weed Course Succeed?

At the end of the course I talk with 90% of the students when they pick up their final exam. We discuss what they get from the course. Most believe they learn something of value. Most say the weed course was one of the few that taught something about crop production. Most wish there were more weed courses they could take.

A good single weed course, like petting, succeeds and fails at the same time. It introduces the student to the subject. He tries it and likes it. But he is not satisfied knowing he has much more to learn.

The persistent student also ask, "When will the University have a second weed course"? When one man must advise 5 to 10 undergraduates and 4 to 5 graduate students and serve on the committees of 15 other graduate students, teaching a weed course both semesters would end any pretense of a weed research program. So you answer that a second weed course will be started when a second weed man is hired at the University. But this is a false hope. At a college with 55 Entomologists and 27 Plant Pathologists teaching 19 Entomology and 10 Plant Patholoy courses, which now fail to enroll enough students to justify teaching these courses, there is little hope in increasing the number of weed men and weed courses by 100%.

The truth is, that when I become too weak to handle a sprayer, too blind to drive a pickup to look at weeds and crops in the field, and too deaf to answer the phone helping farmers, applicators and housewives with their weed problems, I will then be prepared to teach an advanced weed science course.

MINUTES OF THE BUSINESS MEETING
MARCH 16, 1972

President Appleby called the meeting to order at 10:30 a.m. with 55 members in attendance. Minutes of the last meeting were accepted as presented by unanimous vote. All in attendance stood in a moment of silence as a memorium to deceased former member and WSWS Secretary C. H. (Larry) Slater.

MARCH 16, 1972

Nominations Committee Report — P. E. Heikes. New officers selected by 131 ballots returned by members.

President Elect ....D. L. Burgoyne
Secretary Elect ....Gary Lee
Chairman Elect
Research Section ....Ed Schweizer
Chairman Elect
Extension/Regulatory ....A. H. Lange

Treasurer-Business Manager Report — J. L. Anderson Finance committee representative, J. R. McKinley presented audit information on J. L. Anderson's reports and made the motion for acceptance as presented Membership voted unanimously for acceptance.

Local Arrangements Committee Report — L. A. Jensen expressed his thanks to member helpers who assisted in operating the meeting.

Local Arrangement Committee Chairman for 1973, K. Wallace, announced that the 1973 meeting would be held in Spokane, Washington at the Ridpath Hotel on March 13, 14 and 15, 1973.

Site Selection Committee Report — J. Hodgson announced that the 1974 conference would be held in the State of Hawaii.

Resolutions Committee Report — H. L. Morton presented three resolutions to be forwarded to appropriate federal offices for consideration.

Resolution No. 1

WHEREAS: Noxious weeds grow on Federal land and spread to other lands causing millions of dollars economic loss and

WHEREAS: the Carlson Foley Bill which became law in 1968 has not been funded, in part due to lack of plan of coordination

THEREFORE: be it resolved that the Western Society of Weed Science in session at Salt Lake City, Utah, on March 16, 1972, supports the passage of Senate Bill Ammendment 1209 of the Carlson Foley Act of 1968.

Resolution No. 2

WHEREAS, many of the most damaging weeds to agriculture are introduced from foreign countries, and

WHEREAS, a study in the U.S. Department of Agriculture estimates that there are 1,450 weed species that are causing economic problems in other countries but which are not yet present in this country, and

WHEREAS, weed plants such as *Hydrilla* sp., *Rottboellia exaltata,* alligatorweed, witchweed, and others, are still being introduced into this country because of the lack of quarantine authorities and measures to prevent or restrict their introduction, and

WHEREAS, surveys are needed to determine the extent of new infestations, and

WHEREAS, authorities and activities are needed to localize and eradicate such infestations, and

WHEREAS, weeds such as *Rottboellia exaltata* can be freely spread from one area to another within the United States, and

WHEREAS, the introduction of new noxious weeds not only adds to the burden of the farmer in cost of control, increases costs of research and education in developing new methods to control such exotic weeds but also may require new chemicals and higher rates of herbicide exposure in the environment, and

WHEREAS, there are regulatory programs that aid in dealing with problems related to introduction of other foreign pests such as insects, plant diseases, nematodes, and animal diseases, and

WHEREAS, a draft Federal Noxious Weed Law has been prepared that would deal with these problems, therefore

BE IT RESOLVED that the Department of Agriculture sponsor such legislation that will prevent the introduction of exotic noxious weeds and facilitate the locating and eradicating of newly introduced and potentially serious weeds in this country.

The Western Society of Weed Science in session at Salt Lake City, Utah, on March 16, 1972, supports unanimously the sponsorship by the U.S. Department of Agriculture of such legislation.

Resolution No. 3

WHEREAS, terms now used to define land use, such as cropland, non-crop land, range, pasture, forest, watershed, spot treatment, etc., are subject to varying interpretation, and

WHEREAS, confusion arises as to legal uses of herbicides because of uncertainty of definitions of such land use terms,

THEREFORE, be it resolved that the Western Society of Weed Science requests the Weed Science Society of America, through appropriate committees and in consultation with concerned agencies to develop adequate and usable legal definitions of such land use terms.

W. A. Harvey made a motion to have the WSWS prepare a resolution dealing with legally acceptable nomenclature to define "*land uses*" and "spot treatment" with particular reference to labeling requirements for herbicides. The resolution to be forwarded to the Terminology Committee or other designated officials of the Weed Science Society of America for review and adoption. The motion for preparation of the resolution was approved unanimously by members with initiating action to be carried out by President D. E. Bayer assisted by W. A. Harvey and further, that the WSWS be represented on the committee established for action by the WSSA after they reecive our resolution.

Gary Lee, Chairman of ad hoc committee on editorial policy and for rules of acceptability for papers submitted to the Research Progress Reports suggested the new rules; approved by the Executive Committee, be mailed to the membership or be published in the proceedings for the benefit of all members.

Dave Bayer as retiring chairman of the program committee expressed the need for listing of subjects to be discussed at panel sessions. He announced the Executive Committee decision to hold the "What's New In Industry" session in abeyance for annual review before reinstatement. He also put forth a call to any or all members for suggestions on improving the program for future meetings.

Extension and Regulatory Section — Harry Agamalian gave a brief report on the sessions held by the Extension/Regulatory Section and announced that the chairman elect for 1974 was A. H. Lange, U.C., Parlier.

Research Section — Peter Frank gave a brief report on the sessions held by the Research Section and called on each of the project chairmen for reports.

Project 1. Perennial Herbaceous Weeds Chairman elect for 1974, Warren G. (Skip) Purdy.

Project 2. Herbaceous Range Weeds Chairman elect for 1974, Dale Christienson.

Project 3. Undesirable Woody Plants Chairman elect for 1974, Don Oliver.

Project 4. Weeds in Horticultural Crops Chairman elect for 1974, Ken Dunster.

Project 5. Weeds in Agronomic Crops Chairman elect for 1974, Larry Burrill.

Project 6. Aquatic and Ditchbank Weeds Chairman elect for 1974, Gene Otto.

Project 7. Chemical and Physiological Studies Chairman elect for 1974, Bob Zimdahl.

There was discussion from the floor to extend the Aquatic and Ditchbank Weed Project to include — Non crop and/or Industrial Sites, also for the Herbaceous Range Weeds project to include Forests. President Appleby requested that suggestions for project title changes be forwarded through the program chairman for consideration by the Executive Committee. Outgoing WSWS President Appleby turned over his duties to incoming President Dave Bayer. Motion from the floor for adjournment. Seconded by W. A. Harvey. Meeting adjourned at 11:30 a.m., March 16, 1972.

Respectfully submitted,

D. L. Burgoyne
Secretary

REPORT OF WSWS REPRESENTATIVE TO WSSA, 1972

The 1972 meeting of Weed Science Society of America (WSSA) was February 8-10 at the Sheraton-Jefferson Hotel in St. Louis, Missouri. Six hundred and thirty eight people registered. Attendance at WSSA increased from 1971 in contrast to a decrease in attendance at some of the regional conference.

The Executive Committee of WSSA met with President D. L. Klingman on February 7. The business meeting of WSSA was February 8. The Executive Committee met with our new President, R. P. Upchurch on February 10.

New officers of WSSA are:

President-Elect	E. G. Rodgers
Vice-President	E. L. Knake

New members of the Executive Committee are:

D. E. Bayer	Member-at-large
L. S. Jordan	Member-at-large
S. N. Fertig	Member-at-large
W. B. Duke	Northeast, Weed Sci. Soc. Representative

During the past year WSSA expenses exceeded income by $15,000. This was due primarily to increased printing costs for Weed Science. Several actions were taken by WSSA to improve its financial position. No new expenditures were approved that were not covered by expected income. The page charges for Weed Science were changed from 75% of past printing costs to 75% of expected printing costs. This means page charges are now $60 per page. Membership in WSSA was increased to $20 per year; subscription to Weed Science, to $25 per year. Registration fees for meetings of WSSA were increased to $15 for members; $20 for non-members. There will be a $10 fee for non-members of WSSA for listing Positions Available and Positions Desired in Weed Science.

The new editor of Weed Science is T. J. Sheets. New Associate Editors of Weed Science are R. A. Peters and T. J. Muzik. The editor of Weeds Today is G. A. Buchanan.

The next meting of WSSA will be at the Regency Hyatt House, 265 Peachtree Street, N.E., Atlanta, Georgia 30303 on February 5-8, 1973. Rooms will be expensive. Following meetings will be in Las Vegas, Nevada in 1974; Washington, D.C. in 1975; Denver, Colorado in 1976; St. Louis, Missouri in 1977; and Dallas, Texas in 1978. — K. C. Hamilton.

FINANCIAL STATEMENT OF THE WESTERN SOCIETY OF WEED SCIENCE

MARCH 10, 1971 — MARCH 1, 1972

Income		
On hand, March 10, 1971	$3,765.16	
Registration, Denver Meeting	666.00	
Dues, members not attending Denver meeting	95.00	
Denver luncheon tickets	575.00	
1971 Research Progress Reports	1,053.14	
1971 Proceedings	1,081.14	
Sale of old publication	76.00	
Payment of outstanding accounts	34.12	
Interest on savings	34.64	
Advance order payments	8.00	
	$7,388.20	
Expenditures		
Annual meeting incidental expenses	374.50	
Denver luncheon	686.61	
1971 Research Progress Reports	772.86	
1971 Proceedings	1,072.00	
Office supplies	182.05	
Business manager honorarium	250.00	
Larry Slater memorial fund	100.00	
Postage	218.30	
Placques for honorary members	27.00	
Gratis publications (27)		
	$3,683.32	
Liquid Assets		
Savings		($2,400.00)
Checking		($1,304.88)
Accounts Receivable	105.00	
Potential New Worth	$3,809.88	
Old Publications on hand (585)		

Project 2 Report — Herbaceous Range Weeds — L. E. Warren

Thirty attendees participated in discussion of the following items:

Funds are needed for Federal Agencies to cooperate in treating infestations of noxious weeds on Federal lands. Much of the lands are in Federal ownership, and local managers like to cooperate but don't have funds. The Carlson-Foley Bill is set up for this but not funded; a bill has been introduced to authorize such funds. We should contact our Congressmen to urge passage of this bill.

We discussed the needs for better definitions of cropland, range and cultivated lands by EPA. A resolution urging this was accepted by the Conference.

Overall objective of the discussions was an attempt to stimulate integration of bits and pieces of research into range managers' programs. Weed people may be in the best position to aggressively pursue this. Priorities for range resources need to be established then we should go out and peddle our ideas, show how they can work and demonstrate the economic and environmental advantages.

Poisonous Weeds

In various areas, losses may be higher than previously thought through long term debilitation, teratogenic and carcinogenic effects. Also of interest is the possible transmission of toxins to humans through milk or meat of animals grazing on poisonous weeds. This is known for certain poisonous weeds.

Surveying for infestations is difficult, but losses justify extensive inputs in certain areas. Most important weeds appeared to be larkspur, locoweed, tansy ragwort, bracken fern, broom snakeweed, poison hemlocks, lupines and halogeton.

Experience shows that attempting to *eradicate* infestations from ranges may be practical only for a few species in restricted areas. Depending on the nature of the weed, its location, and toxic effects, reducing density of stands greatly and timing of grazing thereafter seems most practical. Halogeton is an example of failure to contain poisonous weeds. However, we still need efforts to stop these early infestations. Regarding costs, a figure of $40 per acre on "spots" was readily arrived at; larger amounts may be justified.

Annual and Perennial Broadleaf Weeds

Great concern was expressed about rapid invasion of annual or perennial grasslands by yellowstar thistle, yellow, diffuse and spotted knapweed in the Northwest. Grazing restrictions to reduce invasion have not been successful; chemical treatments are needed. There has been some success in recovering infested range by this means — repeat low dose treatments with TORDON at 1 to 4 oz./A every few years may be successful on Scotch, musk, yellowstar thistles and the three knapweeds. Chemical treatments of skeleton weed, fringed sagewort, dalmation toadflax have not stopped advances but have greatly reduced them and are probably very worthwhile. More clearances are needed to allow use of more effective treatments.

Conversion of annual to perennial grasses would probably be a good investment over much of the West; reseeding is necessary much of the time. Medusahead and cheatgrass are the main annual grass problems. Good drilling equipment and methods are needed to ensure a stand. More work is required to demonstrate desirable mechanical and chemical treatments to achieve good results from these conversions to perennial grasses. Adapted perennial species seem to be available but in some areas annual grasses may be a desirable management objective.

One of the most important problems may be how to educate and deal with the public to cooperate in reducing spread of weeds — sportsmen, recreationists, tourists who pick flowers and toss them out the window when they dry; hay and seed transporting are also sources of spread. Public awareness of cost and hazards from weeds may be a very important factor in helping us.

HONORARY MEMBERS OF WSWS

The new constitution of the Western Society of Weed Science adopted in 1967 provided for the selection of honorary members of WSWS. Five individuals were initially selected as honorary members in 1968 and two have been selected each year thereafter. The following have been so honored by the Western Society of Weed Science:

Robert B. Balcom, 1968
Walter S. Ball, 1968
A. S. Crafts, 1968
F. L. Timmons, 1968
D. C. Tingey, 1968
Lambert C. Erickson, 1969
Jesse M. Hodgson, 1969
Lee Burge, 1970
Bruce Thornton, 1970
Virgil H. Freed, 1971
W. A. Harvey, 1971
H. Fred Arle, 1972
Boysie E. Day, 1972

H. FRED ARLE

Mr. Fred Arle was born November 13, 1913 in Norwod, Minnesota. He received his B. S. in Forestry from the University of Minnesota in 1936. He worked at many jobs while waiting for the depression to end. In 1940 he joined the U. S. Navy Air Force and served as a pilot of twin-engine planes.

In 1946 he joined the Bureau of Plant Industry and the war on weeds working in Mississippi and Texas. On April 10, 1948 he was transferred to, Phoenix, Arizona to work on control of weeds on irrigation systems. Earlier work on aromatic petroleum oils for control of ditchbank weeds and submerged aquatics was rewarding but the endless hours of discussing the merits of various emulsion stabilizers with Bureau of Reclamation personnel forced him into other fields.

He returned to the University of Minnesota in 1953 to earn an M.S. in Forestry. His greatest contribution in Weed Research was the development of "layby" herbicide applications in cotton. Although he has worked in all of the crops in Arizona he is best known for his cotton weed research. He has been a constant supporter of the Western Society of Weed Science. He has contributed more than 100 reports to the Research Project Reports, served on many committees and attended every meeting for the past 19 years.

BOYSIE E. DAY

Boysie Eugene Day was born on September 9, 1917 in Haile, Louisiana. When he was still a young boy, his family moved to Tucson, Arizona, where he attended local schols. As an undergraduate at the University of Arizona, he majored in ecology and minored in general botany, receiving his bachelor of science degree in 1939. He entered graduate school on a plant anatomy fellowship and in 1940 was awarded the master of science degree by the University of Arizona for a major in plant physiology.

Between 1940 and 1946, Day served with the U.S. Army. He was stationed in Panama and participated in a series of battle campaigns from New Guinea to the Phillipine Islands. His military experience was continued after World War II in the United States Army Reserve, which he retired from with the rank of colonel.

In 1946, Day enrolled in graduate school at the University of California, Berkeley. In 1948, he transferred to the Davis campus of the University of California, where he received a Ph.D. degree in plant physiology in 1950. On July 1, 1950, Dr. Day joined the staff of the Citrus Experiment Station at the University of California, Riverside as a junior plant physiologist. In 1965, he was appointed a professor of horticultural science.

Dr. Day was named vice-chairman of the horticultural sciences department at Riverside in 1965 and from 1966 to 1968 served as department chairman. In 1968, he was appointed to the post of associate director of the Citrus Research Center and Agricultural Experiment Station at Riverside. He is now director of the University of California statewide Agricultural Experiment Station in Berkeley.

Dr. Day has made numerous outstanding contributions to weed science, including research on the development of herbicides for noncultivation weed control in citrus orchards and other crops. He has been recognized both nationally and internationally as a leader in weed science, and has made significant basic contributions to the knowledge of the rates and mechanisms involved in the degredation of herbicide chemicals in the soil and to their mode of action in the soil. He served as chairman of the National Academy of Sciences Subcommittee on Weeds. Dr. Day is the author or co-author of more than a hundred publications dealing with weed science. He has served the Western Society of Weed Science as Project Chairman and Chairman of the Research Section and was a member of the Executive Committee from 1956-1959. He has also served as program chairman, vice-president, and president of the Weed Science Society of America.

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