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CHEMICAL WEED CONTROL IN ROSE NURSERY FIELDS

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In these experiments of chemical weed control in rose nursery fields, cuttings were planted in the bottom of furrows in late December and early January. These were irrigated twice weekly until rooted. A month to five weeks after planting, CMU, DCMU, SES, CIPC, IPC, and alanap were applied to the soil in the furrows. CMU and DCMU controlled all weeds, and the two phenylcarbamates were of only limited effectiveness. Alanap controlled the weeds but caused serious injury to the roses. Treatments of CMU and DCMU applied in April proved to be as toxic to the roses as to the weeds, while three phenylcarbamates applied at that time provided excellent weed control without damaging the roses.

Later in the season, contact sprays were applied to the weed growth and to the rose stems without wetting the foliage of the cuttings. Various mixtures of a relatively nontoxic kerosene with an aromatic oil and with dinitro butylphenol were tested. All formulations effective against the weeds were found to be more or less toxic to the roses. The kerosene-dinitro formulations were somewhat more selective than the oil mixtures. Emulsions of dinitro butylphenol applied in the same way killed all weeds present except grasses and knotweed. Endothal controlled all weeds present except species of Chenopodium. The rose stems were resistant to a wide range of concentrations of both materials.

DCMU, CMU, phenylcarbamates, DNOSBP, and endothal are promising as practical weed control materials in rose culture.

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CHEMICAL WEED CONTROL IN ROSE NURSERY FIELDS[1,2]

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INTRODUCTION

WEED CONTROL is a major problem in the production of market rose plants. The low, bushy growth habit of the rose prevents close cultivation and makes hand weeding difficult without providing enough shade to suppress weed growth. Weed problems in large-scale rose culture in California fall into two classes, each requiring different solutions: control of perennial weeds and control of annuals.

The roots and other underground parts of perennial weeds often survive after repeated removal of the top. The root system of annuals, on the other hand, is not so resistant. Perennial weeds, such as wild morning-glory, Johnsongrass, Bermudagrass, and nutgrass, constitute individual problems of major importance that justify adoption of long-range crop rotation programs and other management plans for controlling the weeds prior to planting roses. Perennial weeds are controlled first by eliminating the existing stand, then by preventing reëstablishment of new individuals from seed or vegetative parts. Control of wild morning-glory, for example, may require a rotation program in which fields are planted to wheat or barley for one or more years before they are planted to roses. The established morning-glory plants may then be controlled by successive applications of 2,4-D to the grain and to the regrowth following harvest of the grain. In lands infested with Johnsongrass and Bermudagrass, summer fallow with frequent tillage for one or more seasons and spot treatment with dalapon or TCA, may be expected to provide successful control of established stands of these grasses. Once established stands of perennial weeds are brought under control, the measures necessary to prevent reëstablishment are the same as those used to control annual weeds.

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Mechanical and hand tillage methods are generally employed by rose growers to control winter and summer annual weeds. Tractor- or animal-drawn cultivators provide economical control of weeds between the rows, with hand hoeing and hand pulling of weeds between and close to the rose plants at frequent intervals.

Although a number of growers have tried certain chemical control methods, no systematic investigation of the use of herbicides in rose culture has

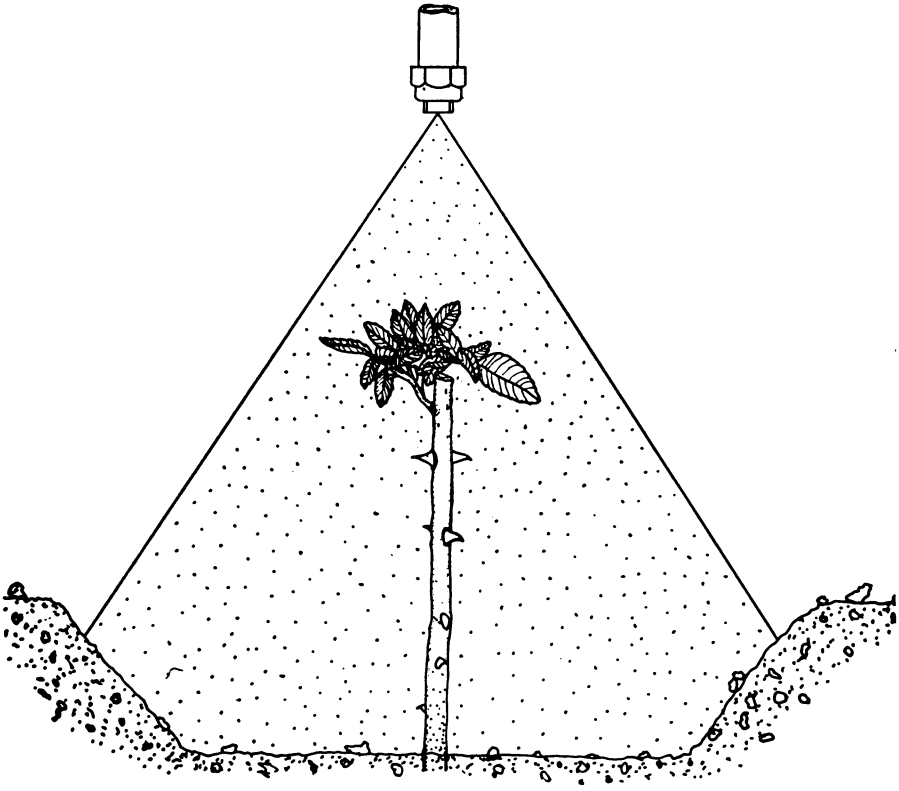

Fig. 1. The method of spraying selective soil sterilants into the furrow of young plantings of roses.

been reported. SES has been used to control weeds in rooted rose cuttings. Kramer and King (1954) reported excellent weed control from experimental applications of SES at the rate of 3 pounds per acre to established rose plantings following cultivation twice during the summer. The roses were not injured. Hamilton and Buchholtz (1953) transplanted roses into undisturbed sod that had been treated with 10 to 40 pounds per acre of CMU, CIPC, endothal, and 20 to 80 pounds per acre of TCA. All treatments except endothal reduced the stand of roses, but CMU greatly stimulated growth in the second season after transplanting. Endothal had little effect on growth of the transplants, and TCA and CIPC retarded growth.

The work reported here was planned to provide information on the tolerance of field-propagated rose cuttings to a number of herbicides during the period from planting of the cuttings in midwinter to budding time in early summer, and to test the effectiveness of herbicides in controlling annual weed growth under the conditions encountered in rose fields. This information provides a basis for the development of chemical methods to reduce and perhaps ultimately to eliminate hand weeding for the six- to eight-month period from planting to budding.

METHODS

Preparation for experiment. Experiments were conducted during the 1953 and 1954 spring growing seasons in commercial rose fields at Ontario, California.[5] Cuttings of the Dr. Huey variety were set out during the first week of January, 1953, and the last week of December, 1953. The cuttings were planted 6 inches apart in rows in the bottoms of irrigation furrows of 42-inch spacing. The furrows were flood-irrigated twice weekly for the first two months, and at less frequent intervals as the plants became established. The soil was Hanford fine sandy loam.

Method of application. Herbicide applications were made in bands centered on the rows of cuttings. The area between rows which can be kept weed-free by tractor work was not treated. When cuttings were young, soil acting herbicides were sprayed on the furrows in bands 10½ to 12 inches wide with a single flat-fan nozzle. The sprays wet the stem and small crown of foliage of the cuttings, although all but a negligible amount of the chemicals fell directly on the soil (fig. 1).

Later in the season, after foliage began to overlap the furrows, soil applications were made from a dual nozzle boom with flat-fan nozzles set to spray underneath the rose foliage (fig. 2). This method was also used to spray contact herbicides on weed growth in the furrows at all stages of growth of the cuttings.

Application rates are reported in pounds of active ingredient per actual acre of furrow sprayed. The furrows constituted less than one third of the land area in the test fields.

Type of weeds. In January and February of both years the early stand of seedling weeds was composed largely of brass buttons (*Cotula australis*), nettleleaf goosefoot (*Chenopodium murale*), lambs quarters (*Chenopodium album*), knotweed (*Polygonum aviculare*), shepherds purse (*Capsella bursa-pastoris*), and annual bluegrass (*Poa annua*). Initial sprayings of soil sterilants were made when the stand of weeds was 1 inch tall. Tests of selective contact sprays were made when the weeds had formed a dense carpet 2 to 3 inches thick. Later in the season additional weed species appeared, including hairy crabgrass (*Digitaria sanguinalis*), white sweetclover (*Melilotus alba*), sow thistle (*Sonchus oleraceus*), and watergrass (*Echinochloa Chrusgalli*).

Evaluation of plots. Plots were rated by visual estimate for control of broadleaved weeds, control of grasses, and injury to the roses. Control of weeds was estimated on a percentage basis with the stand on adjacent control plots considered as 100 per cent. Each plot was evaluated by each of us independently, and estimates were averaged with observations of the other

[5] Fields of the Armstrong Nursery Company.

replicates of the series to form a final evaluation of each specific treatment.

For evaluation purposes, rose injury was divided into three ranges: 1) from 0 per cent to 35 per cent represented a growth retardation or stunting range, in which leaves and other aerial parts were retarded in growth, were malformed or discolored but were not actually killed; 2) from 35 per cent to 65 per cent covered a range in which toxicity was severe enough to kill bud or leaf tissues or even entire branches without being ultimately fatal to

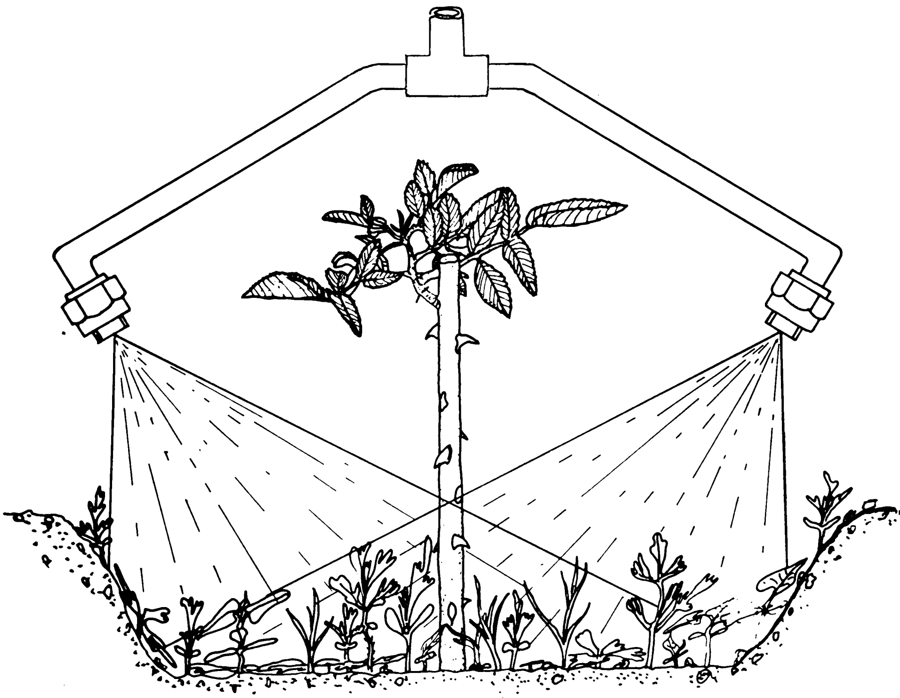

Fig. 2. The method of applying contact sprays to weeds in rose plantings. All of the foliage of the weed seedlings was wet while only the stem of the rose cutting was sprayed.

the plants; and 3) from 65 per cent to 100 per cent was a range in which increasing numbers of plants up to 100 per cent were killed. Further subdivision of these ranges is shown in table 1. Copies of this table were used as work sheets for evaluation in the field. Injury was evaluated by visual estimate by two or more independent observations. Estimates were based on comparisons with roses kept weed-free by hoeing and hand pulling. Roses in untreated control plots were evaluated along with those in treated plots, since plants in control plots soon were off-color and were visibly retarded in growth as a result of unrestricted weed competition.

Active ingredients used. Herbicides and mixtures of herbicides containing one or more of the following active ingredients were used:

Weed Oil—Commercial grade
Kerosene—Commercial grade
DNOSBP—Dinitro *ortho* sec. butylphenol

Endothal—3,6-endoxyhexahydrophthalate
IPC—Isopropyl N-phenylcarbamate
CIPC—Isopropyl N-(3-chlorophenyl)—carbamate
MIPC—Isopropyl N-(3-methylphenyl)—carbamate
CBPC—*Sec* butyl N-(3-chlorophenyl)—carbamate
MCIPC—Isopropyl N-(2-methoxy-5-chlorophenyl)—carbamate
Alanap—N-1 Napthyl phthalamic acid
SES—2,4-Dichlorophenoxyethyl sulfate
Sesin—2,4-dichlorophenoxyethyl benzoate
CMU—3, (*p*-chlorophenyl)—1,1—dimethylurea
DCMU—3, (3,4-dichlorophenyl)—1,1—dimethylurea

TABLE 1
WORK SHEET FOR ESTIMATING HERBICIDE DAMAGE TO ROSES

Rating (Per cent plant damage)	Description of typical plant damage
5	Very slightly retarded growth
10	Moderately retarded growth with off-color or other slight symptoms
20	Severely retarded growth with well-developed toxicity symptoms
30	Little normal growth; severe symptoms such as chlorosis and malformation without actual killing of plant tissue
40	Severe toxicity symptoms accompanied by slight tissue killing, such as burning of leaf tips, killing of bark, necrotic spots, et cetera
50	Moderate tissue damage
60	Severe tissue damage and other symptoms at maximum without actual killing of any plants
70	Maximum expression of symptoms; occasional plants dead
80	About half of plants dead
90	Most of plants dead
95	Occasional survivors
100	All plants killed

The DNOSBP was a commercial formulation supplied by the Dow Chemical Company. The endothal was a commercial formulation supplied by the Niagara Chemical Company. The IPC and CIPC were liquid formulations supplied respectively by the Montsanto Chemical Company and the Geigy Company. The MIPC, CBPC and MCPC were experimental formulations supplied by the U. S. Industrial Chemicals Company. The alanap was applied as a suspension of wettable powder of the acid form supplied by the Naugatuck Chemical Company. The SES was a commercial formulation supplied by Carbide and Carbon Chemicals Company. Technical grade Sesin was dissolved in xylene and applied as a water emulsion. CMU and DCMU were applied as aqueous suspensions of wettable powders containing 80 per cent active ingredients.

SELECTIVE CONTACT SPRAYS

On February 19, 1953, replicate, 50-foot plots were treated with contact herbicides, that is, materials which are toxic only to the parts of plants actually moistened by the sprays. These experiments were designed to determine the tolerance of the rose stems to both oil-soluble and water-soluble contact sprays, and to evaluate the toxicity of these herbicides to surround-

TABLE 2

PER CENT WEED CONTROL AND CROP DAMAGE RESULTING FROM APPLICATION OF CONTACT HERBICIDES TO WEED GROWTH AND TO THE STEMS (BUT NOT THE FOLIAGE) OF SIX-WEEK-OLD ROSE CUTTINGS

Material and rate	Per cent control		Per cent rose injury	Remarks
	Broadleaf weeds	Grasses		
Control	0	0	5	Roses retarded by weed competition
Weed oil*	100	100	80–90	Roses partially or entirely girdled; many killed
80% weed oil; 20% kerosene*	100	80–90	70	Discoloration and partial girdling of stems of roses
60% weed oil; 40% kerosene*	70	70	5	Slight discoloration of rose stems; leaf discoloration; complete recovery
40% weed oil; 60% kerosene*	30	30	5	Slight yellowing of rose leaves; rapid recovery
20% weed oil; 80% kerosene*	30	30	5	Temporary yellowing of rose leaves
Kerosene*	0	0	5	Temporary yellowing of rose leaves; complete recovery
DNOSBP 2 lbs/A in kerosene*	90	100	10	Rose stems discolored. Some growth retardation; rapid recovery
DNOSBP 4 lbs/A in kerosene*	90	90	70	Partial to complete girdling of roses
DNOSBP 6 lbs/A in kerosene*	100	100	80	Rose stems discolored, many girdled and killed
DNOSBP 2 lbs/A in 100 gal water	100	0	0	
DNOSBP 4 lbs/A in 100 gal water	95	0	0	Several knotweeds were only broadleaved plants surviving
DNOSBP 6 lbs/A in 100 gal water	100	0	0	
Endothal 6 lbs/A in 100 gal water	90	100	0	Chenopodium species survive
Endothal 9 lbs/A in 100 gal water	95	100	5	Chenopodium species survive
Endothal 12 lbs/A in 100 gal water	95	100	10	Some plants of Chenopodium species survive; growth of roses retarded; recovery rapid

* All oils and fortified oils applied at rate of 40 gal/acre emulsified with 60 gal water.

ing weeds. The weed stand was then 2 to 3 inches tall and had formed a dense carpet composed mainly of *Cotula*, but with other species present. The herbicides were applied as directed sprays to the weed growth and rose stems without wetting the foliage of the roses.

Oil emulsion formulations. These formulations, of varying toxicity, were made by blending odorless kerosene with a commercial weed oil of the following specifications: gravity (API), 20; viscosity (Saybolt), 40; flash point, 175° F; initial boiling point, 475° F; end point, 675° F; and aromatic content, 52 per cent. Oil mixtures varying in composition from straight kerosene to undiluted weed oil were tested at the rate of 40 gallons of oil mixture per acre applied as an emulsion with 60 gallons of water per acre. Other oil formulations tested were composed of 40 gallons of kerosene fortified with 2, 4, and 6 pounds of DNOSBP and emulsified with 60 gallons of water. These sprays were applied at the rate of 100 gallons per acre. Two, four, and six pounds per acre of DNOSBP were also tested as water emulsions by emulsifying appropriate amounts of a commercial formulation of dinitro general contact herbicide with water at the rate of 100 gallons per acre. All emulsion formulations were stabilized by the addition of 1 per cent by weight of laundry detergent. Solutions of endothal were applied at rates of 6, 9, and 12 pounds per acre in 100 gallons of water. The endothal used was a commercial formulation containing a wetting agent. No additional surfactant was added.

Plots were rated for weed control and rose injury, one week, four weeks, and eight weeks after treatment. Data are summarized in table 2. Mixtures of aromatic oil in kerosene show no distinct range in which selective weed control seems feasible. Effective weed control was accompanied in all instances by moderate to severe damage to the stems of the cuttings. Kerosene fortified with dinitro general was somewhat more selective than the kerosene-weed-oil mixtures. The 2-pound rate gave satisfactory control without permanent injury to the rose stems. In the use of contact herbicides which wet the stem of the rose, the margin of selectivity must be wide since damage occurs in the region of the stem later used for budding. These results indicate insufficient selectivity with oils to accomplish practical weed control with reasonable safety.

Emulsions of dinitro general in water. These were effective against the broadleaved weeds but did not control the grasses. The irrigation furrows were converted from a mixed stand of predominantly broadleaved weeds to solid stands of annual grass. The margin of selectivity between the rose stems and susceptible weeds is wide. This material could provide weed control with safety in fields where weedy grasses are not a problem.

Endothal was effective against all weeds present except the two species of Chenopodium, although at the highest rate of application the stand of these weeds was reduced. There was excellent selectivity with respect to the other weeds present. Because some toxicity to the roses was apparent at the 12-pound rate, it is unlikely that increased rates of application would permit control of Chenopodium species without rose damage. Endothal at rates of 6 to 9 pounds per acre may be useful as a practical weed control method in fields not infested with Chenopodium species. A combined spray of 2 to 4 pounds of dinitro general with 6 to 9 pounds of endothal might be expected to remove all weed growth selectively. Such sprays could be applied during the period from planting of the cuttings to the time when the rose foliage has overgrown the furrows. Unless longer cuttings are planted than is the usual practice and these set high, use of selective placement sprays would be limited to a few weeks in the spring before foliage spread limits further spraying.

SELECTIVE SOIL STERILANTS

A series of test plots using soil-acting herbicides was started February 11, 1953. Rows of cuttings were divided into plots 50 feet long. Herbicide treatments were sprayed on the furrows in bands 10½ inches wide. The area of each plot was thus approximately 1/1,000 of an acre. Applications were made with a flat-fan nozzle in a total volume of 100 gallons per acre. At the time of treatment the cuttings had developed crowns of foliage 1 to 3 inches in diameter. The basal ends were callused, with occasional roots ⅛ inch or less in length. A uniform stand of seedling weeds less than 1 inch tall was present. The materials used were CIPC, IPC, SES, CMU, and alanap. CIPC, IPC, alanap, and CMU were applied at rates of 2,4, and 6 pounds per acre. SES was used at rates of 1½, 3, and 4½ pounds per acre. Mixtures of CIPC and SES were applied at 2 pounds per acre of CIPC plus 1½ pounds of SES and at 4 plus 3 pounds per acre respectively, and at 6 plus 4½ pounds per acre respectively. Quadruplicate plots of each treatment and 18 untreated control plots were located at random throughout the experimental area. Weed control was evaluated at frequent intervals for nine weeks until it became necessary to hoe the weeds in the controls and some of the treated plots in order to permit the flow of irrigation water. Response of the roses in all plots and effectiveness of weed control in some plots were observed until budding time in June. Results from these tests are summarized in table 3.

CIPC and IPC. These were effective against the grasses and also reduced the stand of broadleaved weeds during the first six weeks following treatment. However, a sufficient number of broadleaved weeds, particularly *Cotula,* remained to spread and form a ground cover later in the season, which was only slightly less dense than that present in the controls. Both compounds controlled weed seed germination for a short time after application. The heavy leaching of the soil with bi-weekly furrow irrigation probably accounts for the short-lived effectiveness of these materials.

SES. At all rates SES had no apparent effect on either the weed growth or the rose cuttings. It is probable that this material, which is a great deal more soluble than IPC and CIPC, was rendered ineffective as a result of being rapidly leached below the root zone of the seedling weeds. SES, which was used in mixtures with CIPC with the expectation of combining its usual effectiveness against broadleaved weeds with CIPC's toxicity to grasses, was ineffective in these treatments also. The results were similar to those obtained with the same amounts of CIPC alone. Because of the heavy watering schedule it seems doubtful that water soluble herbicides that must be absorbed by roots could be effective in the early stages of rose propagation.

Alanap. Both alanap and CMU remained effective over a long period of time presumably because of their low solubility and resistance to leaching. Alanap killed the younger seedlings and controlled the germination of new weeds for the duration of the experiment. It failed to kill some of the larger seedlings of the existing weed stand, but prevented their further growth. Although alanap provided satisfactory weed control at rates of 4 to 6 pounds per acre throughout the period from planting to late spring the accompanying rose damage would make its use in rose culture impractical.

CMU. This chemical provided 100 per cent weed control at each of the three rates tested. All weeds were controlled for 10 to 14 weeks by the 2-pound rate, and for 16 to 20 weeks by the higher rates of application. At 6 pounds per acre, rose damage was severe; however, at lower rates an ample margin of selectivity was apparent. At the 2-pound rate, rose growth was

TABLE 3

PER CENT WEED CONTROL AND CROP DAMAGE TWO MONTHS AFTER APPLICATION OF SELECTIVE SOIL STERILANTS TO MONTH-OLD ROSE CUTTINGS

(All figures based on four replicates)

Herbicide	Per cent control		Per cent rose injury	Remarks
	Broadleaf weeds	Grasses		
Control	0	0	10	Rose growth retarded by weed competition
CMU 2 lbs/A	100	100	5	Complete control of all weeds with negligible damage to roses at lowest rate
CMU 4 lbs/A	100	100	15	
CMU 6 lbs/A	100	100	60–70	
IPC 2 lbs/A	10	100	5	Surviving broadleaved weeds rapidly spread to give thick ground cover filling space resulting from removal of grass
IPC 4 lbs/A	15	100	5	
IPC 6 lbs/A	75	100	5	
CIPC 2 lbs/A	50	90	5	*Cotula* was principal surviving weed at all rates of treatment
CIPC 4 lbs/A	50	100	10	
CIPC 6 lbs/A	70	100	50	
SES 1½ lbs/A	0	0	5	
SES 3 lbs/A	0	0	5	
SES 4½ lbs/A	0	0	5	
CIPC 2 lbs/A SES 1½ lbs/A	50	90	5	Results similar to plots in which CIPC was used above; symptoms of CIPC damage less in these plots
CIPC 4 lbs/A SES 3 lbs/A	50	100	5	
CIPC 6 lbs/A SES 4½ lbs/A	50	100	15	
Alanap 2 lbs/A	50	50	10	Plots variable; surviving weeds severely stunted; *Poa annua* relatively resistant; severe damage to roses at 6-pound rate
Alanap 4 lbs/A	90	90	15	
Alanap 6 lbs/A	95	60	60	

somewhat stunted with a slight development of the variegated chlorosis characteristic of CMU toxicity. (See Hoffman and Sylvester, 1951; Pavlychenko, 1951.)

Unlike the other soil sterilants tested, CMU drifted along the furrows with the irrigation water. Since CMU is similar in solubility to IPC and CIPC, neither of which migrated along the furrows, it seems likely that the CMU which was applied as a wettable powder, moved in suspension with the irrigation water. Where drift into some of the control plots had occurred, the effectiveness of the CMU against weeds and its toxicity to roses decreased with increasing distance from the treated plot. In such cases stunting and

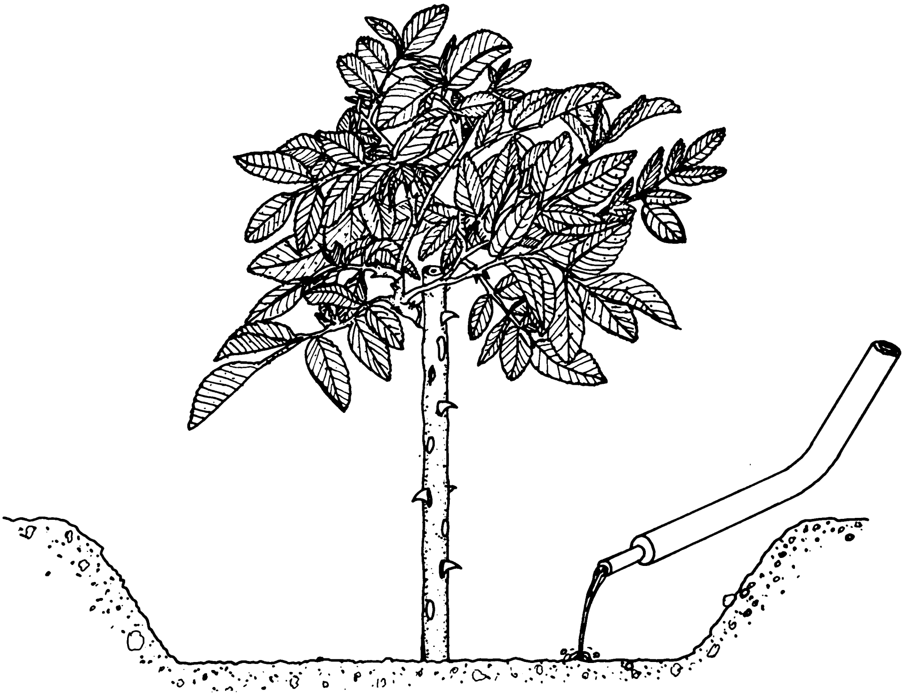

Fig. 3. The method of pouring CMU suspensions into the irrigation furrows. Subsequent irrigation distributes the herbicide throughout the furrow.

TABLE 4

PER CENT WEED CONTROL AND CROP DAMAGE SIX WEEKS AFTER TREATMENT OF 14-WEEK-OLD ROSE CUTTINGS WITH CMU BY SPRAYING ON THE SOIL AND BY POURING INTO THE FURROW

Rate and method of application	Per cent control		Per cent rose injury	Remarks
	Broadleaf weeds	Grasses		
Control	0	0	2	Slight retardation of rose growth by weed competition
½ lb/A sprayed	80	80	30	Yellowing of rose leaves and severe stunting
1 lb/A sprayed	100	100	70	Browning of rose leaves from margins inward; entire branches killed
1½ lbs/A sprayed	100	100	70	Browning of rose leaves from margins inward; entire branches killed
2 lbs/A sprayed	100	100	80	Maximum CMU symptoms on surviving roses; some killed
1 lb/A poured	100	100	40	Marked CMU symptoms; severe stunting of roses
1½ lbs/A poured	100	100	60	Roses severely injured
2 lbs/A poured	100	100	60	Roses severely injured

other toxicity symptoms disappeared before the limit of effective weed control was reached, indicating that at lower rates than those tested weeds can be controlled by CMU without producing toxicity symptoms or reducing the growth of the roses. In an effort to verify this finding in the same growing season, new CMU plots were treated with lower rates of CMU on April 23, 1953.

Treatments were applied without replication to entire 600-foot rows from which all weeds had been removed by hoeing. Rates of ½, 1, 1½, and 2 pounds per acre of CMU suspended in 100 gallons of water were sprayed into the irrigation furrow, using dual nozzles directed below the crown of rose foliage. Precise adjustment of nozzle height was necessary to prevent excessive shielding of the furrow by the rose foliage. To test a method of avoiding this difficulty other rows were treated with 1, 1½, and 2 pounds per acre of CMU, in 100 gallons of water by pouring the suspended material at low pressure from a pipe directly on the soil surface on one side of the furrow, as shown in figure 3. Results from this experiment are shown in table 4.

It is evident that the roses were a great deal less tolerant to CMU applied at this later stage of their development. The well-established roses were as sensitive to the CMU as were the weeds. This loss of selectivity may be related to the reduced watering schedule, higher temperatures, or, more probably, to the extensive root system present on the cuttings in the zone of leaching of the chemical. The use of CMU as a selective herbicide prior to budding may be limited to early applications.

The fact that pouring the suspended material into the furrow was about as effective as spraying is of interest. The suspension was poured on one side of the furrow, and weed control was apparently equally effective throughout the irrigated area of the furrow. Although irrigation water may facilitate distribution of CMU for weed control under some conditions, the need for careful disposal of drainage water from CMU-treated areas is indicated.

MIPC and CBPC. Since the relative ineffectiveness of the phenylcarbamates IPC and CIPC in early season tests may have resulted from their excessive leaching, tests were made with materials of this type after the cuttings were rooted and the watering schedule was reduced. On April 23, 1953, immediately following tillage and hand weeding, plots of 100 feet of furrow were sprayed with three rates of three different phenylcarbamate herbicides. Sprays were applied beneath the rose foliage, covering the soil in the furrows uniformly. MIPC and CBPC were applied at 2, 4, and 8 pounds per acre, and MCIPC at 3, 6, and 12 pounds per acre. The plots were irrigated immediately following application and at two-week intervals thereafter. Weed control and rose injury data are given in table 5.

These materials were more effective than the similar herbicides IPC and CIPC had been in early season tests. Reduced leaching and the fact that there were no established weed seedlings present in the later tests could account for the better weed control obtained. When the soil is not subjected to excessive leaching, herbicides of this type may be of value in controlling germination of weed seeds in rose plantings.

Phenylcarbamates, CMU and DCMU. A series of experiments with soil-acting herbicides was conducted in the 1954 spring growing season. Initial tests were applied on February 3 to plots of cuttings planted five weeks earlier. Conditions of irrigation, stage of growth of weeds and cuttings, and other factors were similar to those prevailing in early-season experiments during the previous year. Tests were made on randomized, quadruplicate

TABLE 5

PER CENT WEED CONTROL AND CROP INJURY SIX WEEKS AFTER TREATMENT OF 14-WEEK-OLD ROSE CUTTINGS WITH THREE RATES OF THREE PHENYLCARBAMATES

Material and rate	Per cent control		Per cent rose damage	Remarks
	Broadleaf weeds*	Grasses†		
Control	0	0	2	Rose growth judged very slightly retarded by weed competition
MIPC 2 lbs/A	0	0	5	
MIPC 4 lbs/A	80	90	5	New seedlings of watergrass and pigweed emerging
MIPC 8 lbs/A	100	100	5–10	Slight retardation of rose growth
CBPC 2 lbs/A	85	85	5	Seedlings of pigweed emerging
CBPC 4 lbs/A	100	100	5	Seedlings of pigweed emerging
CBPC 8 lbs/A	100	100	5	Roses slightly retarded in growth without injury symptoms
MCIPC 3 lbs/A	50	100	5	
MCIPC 6 lbs/A	75	100	5	
MCIPC 12 lbs/A	90	100	10	Some pigweed survived; roses moderately stunted without specific symptoms

* Broadleaved weeds present: pigweed (3 spp.), lambs quarters, nettleleaf goosefoot, brass buttons, knotweed, shepherds purse, wild mustard (2 spp.).
† Grasses present: watergrass, crabgrass, annual bluegrass.

plots 25 feet long containing 50 cuttings. IPC was applied at rates of 6, 9, and 12 pounds per acre, thus extending tests of this material to double the rates tested in 1953 in an attempt to compensate by increased dosage for possible losses by leaching. CMU was applied at rates of ½, 1, and 2 pounds per acre—extending early-season tests into a lower dosage range than used in similar tests the previous season. DCMU, a derivative of CMU containing one additional chlorine atom, was tested at ½, 1, 2, and 4 pounds per acre. All chemicals were applied suspended in water at the rate of 50 gallons per acre. Weed-control evaluations and rose-injury data are summarized in table 6.

IPC was fairly effective at 12 pounds per acre but its effects were relatively short-lived. DCMU was somewhat more effective at lower rates than CMU, and its effects were more lasting. Six weeks after application, slight toxicity symptoms appeared on the rose leaves in plots treated with CMU at the 2-pound rate. These symptoms were short-lived and had no apparent long-term effect. Injury symptoms did not develop on roses in plots treated with the 2-pound rate of DCMU. DCMU was less toxic to the roses and more effective in weed control than CMU. This greater effectiveness and wider selectivity may be related to the lower solubility of DCMU and the resultant greater localization of the herbicide near the soil surface above the root zone of the rose cuttings.

TABLE 6

PER CENT WEED CONTROL AND ROSE INJURY AFTER APPLICATION OF HERBICIDES TO 5-WEEK-OLD ROSE CUTTINGS

Material	Rate lbs/A	Per cent control						Per cent rose injury after 20 weeks
		Weeds after 6 weeks		Weeds after 10 weeks		Weeds after 20 weeks		
		Broad-leaved weeds	Grasses	Broad-leaved weeds	Grasses	Broad-leaved weeds	Grasses	
Control	..	0	0	0*	0*	0*	0*	15†
IPC	6	0	10	0	0	0*	0*	15†
IPC	9	40	40	20	20	0*	0*	10†
IPC	12	80	100	50	80	10*	10*	10†
CMU	½	98	100	90	95	15	25	5†
CMU	1	100	100	98	98	15	30	5†
CMU	2	100	100	100	100	85	80	0
DCMU	½	100	100	95	95	70	40	0
DCMU	1	100	100	100	100	75	50	0
DCMU	2	100	100	100	100	95	85	0
DCMU	4	100	100	100	100	100	95	20‡

* Overgrown with weeds.
† Stunting caused by weed competition.
‡ Stunting and mottled chlorosis of lower leaves.

Sesin. Additional plots, results for which are not given in the table, were treated with Sesin at rates of 2 pounds per acre and 4 pounds per acre. The crude chemical was dissolved in xylene and applied as a water emulsion, using laundry detergent as the emulsifying agent. The formulation was unstable, resulting in precipitation of the active ingredient and spotty spray distribution. However, weed control was excellent in both plots and extended over a 10-week period without injury to the roses. Further work with improved formulations of this material is needed.

Re-treatments with CMU and DCMU. Individual 400-foot rows of cuttings were treated with CMU at rates of 1 pound per acre and 1½ pounds per acre, and with DCMU at the rate of 1½ pounds per acre. Treatments were made on February 3, 1954, to cuttings planted five weeks earlier. On April 16 the rows that had been treated with the 1½-pound rates of chemical were divided into three equal plots. Two plots in each instance were re-treated with ½ pound per acre and 1 pound per acre respectively of the material originally applied, and the third plot in each instance was not treated a second time. Results are given in table 7.

CMU at the 1-pound rate controlled all weeds for 10 weeks and reduced weed growth for the remainder of the spring season. The initial treatments

TABLE 7

WEED CONTROL AND PER CENT ROSE INJURY RESULTING FROM APPLICATIONS OF CMU AND DCMU TO THE SOIL

Treatment: February 3	Treatment: April 16	Duration of complete weed control (weeks)	Per cent rose injury: April 16	Per cent rose injury: June 23
None	None	0	10*	15*
1 lb CMU	None	10	0	0
1½ lbs CMU	None	12	0	0
1½ lbs CMU	½ lb CMU	16	0	30
1½ lbs CMU	1 lb CMU	20†	0	70
1½ lbs DCMU	None	16	0	0
1½ lbs DCMU	½ lb DCMU	20†	0	40
1½ lbs DCMU	1 lb DCMU	20†	0	75

* Retarded growth and chlorosis resulting from weed competition.
† Experiment terminated after 20 weeks.

of 1½ pounds per acre of CMU and DCMU kept the plantings free of weeds for 12 to 16 weeks respectively without symptoms of injury to the roses. The second treatments were highly toxic to the cuttings, killing most of the foliage and young stems and in some instances the entire plant. These results verify the previous year's finding that selective use of CMU-type chemicals is not feasible late in the spring season.

Tolerance of year-old plants. On February 15, 1954, tolerance tests of CMU, DCMU, and two phenylcarbamate herbicides were made on roses planted in January, 1953, and budded in July, 1953. Quadruplicate plots 25 feet long containing approximately 50 rose plants were sprayed with MCIPC and IPC at rates of 6, 9, and 12 pounds per acre, and CMU and DCMU at 1, 2, and 3 pounds per acre. At the time the sprays were applied, the roses had been topped-back and the scion buds were beginning to develop shoots. Results are given in table 8.

TABLE 8

PER CENT TOLERANCE OF YEAR-OLD BUDLING ROSES TO HERBICIDES APPLIED TO THE SOIL ON FEBRUARY 15, 1954

Material	Rate (lbs/A)	Weed control, April 20	Per cent rose injury: April 20	Per cent rose injury: June 25
MCIPC	6	poor	0	0
MCIPC	9	poor	0	0
MCIPC	12	poor	0	0
IPC	6	poor	0	0
IPC	9	poor	0	0
IPC	12	poor	0	0
CMU	1	fair	0	0
CMU	2	good	0	0
CMU	3	good	15*	0
DCMU	1	good	0	0
DCMU	2	good	0	0
DCMU	3	good	10*	0

* Chlorosis of leaves without evident reduction of growth.

The weed stand in the test field was not sufficient to permit reliable evaluation of weed-control results. Estimates are given in the table in general terms. Only the 3-pound rates of CMU and DCMU caused injury symptoms, and these were of short duration.

DISCUSSION

Of the contact herbicides tested, mixtures of petroleum oils of varying toxicity and oils fortified with DNOSBP afforded at best only a narrow margin of selectivity between control of young weeds and injury to rose stems. Contact herbicides having water as a carrier were more promising than the oils. Emulsions of DNOSBP and solutions of endothal caused little crop damage over a wide range of concentrations, although certain weeds were resistant to each. Plants that are difficult to wet with water solutions, including all grasses and knotweed, survived the dinitro sprays, and plants of the goosefoot family were more resistant to endothal than were other weeds present. Successive spraying with both herbicide formulations or perhaps combination sprays containing both active ingredients might be expected to control weeds resistant to the separate materials without loss of selectivity. Use of contact sprays directed beneath the rose foliage would be limited to a brief period in the spring, prior to the extensive development of top growth on the cuttings.

CMU and DCMU were effective selective soil sterilants for rose cuttings when applied in late winter or early spring before the cuttings were well established. These herbicides withstood severe leaching conditions and afforded a moderate margin of selectivity. CMU was readily distributed in irrigation water and could be effectively applied to furrow-irrigated rose cuttings by pouring a suspension of the wettable powder into the furrow. In the spring after the roses were rooted they increased in sensitivity to CMU and DCMU and became as sensitive to these herbicides as were the weeds. DCMU was a more effective herbicide than CMU and the rose cuttings were less sensitive to it. Under the conditions of these tests CMU and DCMU, when applied at rates of 1½ pounds per acre early in February, provided control of all annual weed growth from planting time about the first of January to the first of May. Rates of application would be expected to vary with soil type and irrigation schedule.

Phenylcarbamate herbicides were ineffective at rates below 10 pounds per acre during the period shortly after the cuttings were planted. Leaching of these materials from the soil by frequent watering at that time probably accounted for their ineffectiveness at low rates. IPC provided satisfactory control of weeds for a short time early in the season when applied at the rate of 12 pounds per acre. Later in the season, when irrigation was less frequent, phenylcarbamates provided weed control with an adequate margin of selectivity.

SES was ineffective when applied soon after the cuttings were planted. As this material is water-soluble, leaching probably accounted for its ineffectiveness. Although it is resistant to leaching and toxic to weeds in low concentrations, alanap was not sufficiently selective to offer promise as an herbicide in roses.

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