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THE USE OF A WOODY PLANT NURSERY IN HERBICIDE RESEARCH

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SUMMARY

An irrigated woody plant nursery was established in 1963 at the Texas A&M Research and Extension Center near Bryan, Texas, to evaluate new herbicides, herbicide mixtures, formulations, carriers, adjuvants, and spray volumes for brush control. Information was also obtained on the propagation, growth habits, phenology, and physiology of a number of woody species that are primary weed problems on rangelands of the Southwest--honey mesquite, huisache, live oak, Macartney rose, whitebrush, winged elm, saw greenbrier, and loblolly pine. The nursery is useful for herbicide research since less space is required for comparable treatments than in field sites, several woody species may be grown in the same area, and nursery-grown and natural stands of brush respond similarly to the same herbicide treatments.

Honey mesquite, huisache, whitebrush, and winged elm can be propagated from seed planted in greenhouse pots and later transplanted in the nursery. Honey mesquite and huisache seed and live oak acorns, however, can also be planted directly in the field for successful propagation. Macartney rose and saw greenbrier are propagated by transplanting sections of roots and rhizomes, respectively, into the field nursery. Yaupon, loblolly pine, and Arizona ash are most successfully propagated by transplants purchased from commercial nurseries.

Conventional land preparation and weed control practices are required for best survival of the brush. Most woody plants can be treated with herbicides within 1 year after planting. Data on various herbicides, herbicide mixtures, formulations, and adjuvants applied at several rates, dates, and years were obtained. Picloram proved to be one of the more effective herbicides studied on most brush species. Some surfactants and diesel oil carriers enhanced the activity of herbicides on some species.

KEYWORDS: Honey mesquite/huisache/live oak/whitebrush/Macartney rose/winged elm/saw greenbrier/yaupon/green ash/Arizona ash/propagation/seedlings/seed/surfactants/carriers/spray volume/adjuvants/formulation/picloram/2,4,5-T/dicamba/bromacil/paraquat/2,4-D/DSMA/sodium azide/potassium azide/amazine/simazine/pyrichlor/amitrole/MCPA/mecoprop/MCPB/dichlorprop/2,4-DB/silvex/karbutilate/ethephon

The Use of a Woody Plant Nursery in Herbicide Research

R. W. Bovey, R. E. Meyer, and H. L. Morton

An irrigated woody plant nursery was established in April 1963 at the Texas A&M Research and Extension Center near Bryan, Texas, for the purpose of evaluating new herbicides, herbicide mixtures, formulations, carriers, adjuvants, and spray volumes for their defoliating and brush control properties. Information was also obtained on the propagation, growth habits, phenology, and physiology of several problem woody species in the Southwest.

The cultivated plants are used to evaluate promising herbicide treatments that might be effective in controlling natural stands of brush and to supplement data obtained from field experiments. The woody plant nursery provides several advantages over field sites in preliminary evaluation of herbicides. First, fewer plants and less space are required per treatment, since plants are of similar age, size, genetic background, and physiological state. A similar environment and soil type also provide more uniform responses of plants to herbicides. Second, one or more species from different locations and climatic areas can be grown and evaluated under the same environment in the nursery. Third, more observations and treatment applications for herbicide, ecological, and growth evaluation studies can be facilitated since the nursery is close to office and greenhouse facilities in comparison to remote field sites. Fourth, irrigation can be used in the nursery on woody plants as an environmental variable with herbicides or other treatments and is sometimes required in drouthy years to sustain growth. Experiments in the field are sometimes lost due to drouth. Finally, the nursery is a source of soil and plant materials for greenhouse and laboratory studies and provides an area for herbicide residue research involving soils, plants, and water.

There are, however, several problems associated with operating a nursery. First, it is expensive to maintain, requiring much labor and specialized machinery. The nursery requires constant care because young plants are subject to livestock, rodent, and insect damage and may require fencing and pesticide treatment. Some

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woody species are difficult to propagate under cultivated conditions, requiring considerable time and experimentation to establish them. Second, weed control in young stands of brush is a constant problem. Brush in natural stands requires little or no upkeep. Third, a woody plant nursery is usually restricted to one location (environment) and may be a somewhat artificial situation; consequently, woody species may not always respond to a given herbicide as they do in natural stands. The nursery is not the final step in developing recommendations for herbicide treatments, but provides a useful link between greenhouse evaluation and large-scale field studies.

NURSERY DESCRIPTION AND OPERATION

Land Description

An area of about 70 acres, located 5 miles northwest of Bryan, Texas on the Texas A&M Research and Extension Center, is used for the field nursery. Ten fields, each from 5 to 15 acres in area, lie between runways of a former airfield (Figure 1). About 60 acres are a Wilson loam soil (udic pellustert) clay. The surface soil was removed from the other 10 acres, leaving what is largely a denuded sandy loam soil.

The area is nearly level with a 0 to 3 percent slope to some manmade drains. Some flooding occurs because of heavy rainfall and slow drainage and runoff from the runways; however, most of the land can be tilled within a few days following rainfall.

Equipment for Land Preparation, Maintenance, and Irrigation

Common farm equipment is used for land preparation and maintenance. A large wheeled tractor (80-110 hp), equipped with disc plow, disc harrow, cultivator, and bedder attachments, is used for soil preparation and maintenance. The land is usually plowed in the fall of the year preceding planting. The soil is bedded (listered) at 40-inch intervals to allow adequate settling for a good seedbed. The next spring the land is disced and rebedded. About half the bed is leveled; and seed, plant parts, or plants are planted in rows on the leveled surface on top of the bed. Planting is done at 10-foot intervals on every third, 40-inch row.

Land with plants less than 1 year old is clean-cultivated between the rows with a regular two-row cultivator set to cultivate plants in a 5-foot swath on either side of one row. Special shields are used between the innermost cultivating shoes and the row to prevent burial of small plants. Cultivating is done three times, or as needed, the first year. Some woody species (excluding honey mesquite or huisache) are sprayed for herbaceous weed control with 2-chloro-4, 6-bis(ethylamino)-*s*-triazine (simazine) in a 10-inch band as soon as they emerge. Soil between the rows of plants 1 year old or older is disced since the plants are too tall to cultivate. Subsequently, the weedy vegetation between the rows and drainage areas is mowed with a 7-foot diameter rotary mower.

Irrigation is used during summer if it is needed to maintain adequate soil moisture for growth of plants under 1 year old (Figure 2). Generally, older plants can withstand natural environmental conditions without irrigation, since many of these species are adapted to the more arid environments of West Texas.

Most areas needing water are flood-irrigated. The irrigation equipment consists of 8-inch and 5-inch diameter aluminum pipe. An 8-inch diameter pipe is connected to a 6-inch diameter water well pipe and is laid on the concrete runways to a header pipe. The 5-inch header pipe, which contains gated pipe, is laid at a right angle to the rows. All 40-inch rows are irrigated even though planting is only done on evey third row or at 10-foot intervals.

Sprinkler irrigation is used where the land slopes too much for flood irrigation. Six 3-inch diameter leader pipes 300 feet long are connected to the header pipe at 40-foot intervals. Three-foot risers with rotating sprinklers are spaced 60 feet apart on the leader pipes.

Plant Propagation

Methods were devised for propagating the various woody plants. Since relatively little was known about their propagation, much time and many resources were expended to determine the best procedures for each species. Four general methods were employed: (1) direct seeding, (2) transplanting seedlings grown from seed in the greenhouse, (3) transplanting vegetative parts from plants grown in wild stands, and (4) transplanting seedlings obtained from commercial nurseries. Since large numbers of plants were needed, most of the planting operations were mechanized.

Rabbits are a major problem in propagating certain seedlings, particularly honey mesquite, huisache, and greenbrier. No satisfactory control measure has been developed.

Research continues on the development of better, more efficient, and more economical ways of establishing woody plants in the nursery. Other species will be introduced into the nursery when possible. Observations continue on propagation and growth patterns of plants already established.

Honey Mesquite. Honey mesquite [*Prosopis juliflora* (Swartz) DC. var. *glandulosa* (Torr.) Cockerell] is propagated from seed either by direct seeding or by transplanting greenhouse grown plants. Honey mesquite seeds are obtained by collecting mature pods from the field in late summer and threshing them with a modified pearling machine described by Flynt and Morton (7). This machine removes the seed from the pod (legume) and, with a sandpaper disc, mechanically scarifies the seed. About one bushel of honey mesquite pods can be threshed in 1.5 man-hours, as contrasted with 160 man-hours required to cut seed from pods with a scalpel. Threshing is done during days of low relative humidity to minimize problems with gumminess of the hygroscopic mesocarp of the legume. The resulting seed can be stored at 35°F for more than 3 years, while maintaining a germination percentage of 90 or more.

Most honey mesquite is planted by direct seeding in the nursery by a tractor-mounted, modified Planet Junior (Figure 3). The seeds are planted about 1-inch deep at 3-inch intervals in 10-foot wide rows (Figure 4). Planting is done in April or May when there is adequate soil moisture and the soil temperature is 65°F or higher.

The seeds germinate rapidly, and the seedlings soon become established with a long tap root (Figure 5). Seedlings are large enough within 2 weeks for cultivation. The plants may be thinned to 2-foot intervals. After successful propagation in the spring, honey mesquite seedlings may grow to 3 to 4 feet tall the first season. The root system of a 14-month-old seedling was found to penetrate into the soil to a depth of over 5 feet and to spread laterally 4 feet.

Honey mesquite can also be transplanted from the greenhouse. Two seeds are planted in 2- x 2-inch peat moss pots filled with a sandy loam soil or in Jiffy peat moss pellets. Plants are subsequently thinned to one per pot. After about 6 weeks in a warm greenhouse (75 to 95°F), the plants are 4 to 8 inches tall and can be transplanted into the field. Also, older plants can be removed from pots in the greenhouse and transplanted into the field. April and May are the best months for transplanting, but with irrigation they can be transplanted anytime if the soil temperature is above 65°F.

Huisache. Huisache [*Acacia farnesiana* (L.) Willd.] produces a legume (seed pod), similar in appearance to honey mesquite. The seeds are removed from the pod with the modified pearling machine as described for honey mesquite (7). Seeds can be mechanically scarified with sandpaper, but best results are obtained by immersing the threshed seeds in concentrated sulfuric acid for 0.5 to 1 hour. The seeds are then rinsed in tap water and allowed to dry. Eighty-five percent or more of the seeds germinated after 2 years when stored at 35°F. Like honey mesquite, huisache can be seeded directly in the field or transplanted from the greenhouse in April or May. Huisache is more vigorous than honey mesquite and can grow 7 feet tall the first growing season and 12 to 15 feet tall after 2 years (Figure 6).

Live Oak. Live oak (*Quercus virginiana* Mill.) is established from acorns planted directly in the nursery, from transplanted seedlings grown in the greenhouse from acorns, and from bare-rooted seedlings purchased from a commercial nursery.

The most economical method is direct seeding. The acorns are harvested in late fall and treated with a combination of fungicide and insecticide to minimize damage by disease and insects. They are either planted immediately or stored 1 year, but few germinate by the second year. The acorns are planted 2 inches deep, 6 inches apart, in rows 10 feet apart. The plants are subsequently thinned to 2-foot intervals in the row.

Live oak plants can be grown in the greenhouse and subsequently planted in the field. Seedlings grown in the greenhouse must be partially shaded for best results until they are about 6 inches tall; otherwise, the stems tend to die back repeatedly. The plants can be propagated by placing them under a greenhouse bench or by covering them with two layers of cheesecloth if they are exposed to direct sunlight. The plants grow 4 to 6 inches tall in about 10 weeks in a warm greenhouse.

Live oak can be propagated from 1-year-old plants from commercial nurseries in February or March. However, this method is more expensive than direct seeding in the field, and only about half the plants survive.

Live oak plants grow slowly. Plants propagated from acorns or transplants grow 2 to 3 feet tall in the first season (Figure 7), and 3 to 5 feet tall by the end of the second season. They are usually large enough for herbicide treatment the second year after planting.

Macartney Rose. Macartney rose (*Rosa bracteata* Wendl.) has been propagated vegetatively from root segments. Plants are mowed, then plowed, to lift the roots to the soil surface. The roots are cut into segments about 3 inches long.

Best results are obtained by transplanting from December to February during cool weather. About 80 to 95 percent of the plants survive. The first plantings at the woody plant nursery were made in June and July 1963 (a dry year), but even with frequent irrigations the first 2 months after transplanting, only 34 percent of the plants became established.

Macartney rose grows rapidly and can be used experimentally in the fall of the first growing season. Macartney rose also spreads rapidly by layering and root sprouts. Cultivation restricts growth of the plant between rows, and mowing the plants reduces spreading and growth in height.

No research has been done at the nursery on the propagation of Macartney rose from seed.

Whitebrush. Whitebrush (*Aloysia lycioides* Cham.) can either be propagated in the nursery from plants transplanted from the greenhouse or by planting crowns with both stem and root tissue from wild stands.

Whitebrush seeds (achene) are harvested by hand stripping seed from the stem tips of plants in the greenhouse, field nursery, or wild stands when mature. Normally two crops of seed are produced annually in the field in May and October. The seeds can be stored for at least 4 years at 35°F.

The seeds are germinated by placing them on sandy loam soil in a greenhouse flat and covering with 0.25 inch of sand. After watering, the flats are placed in a cooler at 35°F for 3 days. The flats are then placed in a warm greenhouse to minimize disease problems. Seedlings grow best at 75 to 95°F. After about 8 weeks, when the seedlings are 1 to 2 inches tall, they are transplanted into 2- x 2-inch peat moss pots filled with sandy loam soil. About 5 weeks later they are 6 to 12 inches tall and can be transplanted into the field (Figure 8).

Whitebrush can be transplanted anytime from April until September when the soil is warm and moist. The plants are placed at 2-foot intervals in rows 10 feet apart. Irrigation may be necessary if they are transplanted in a dry period during the summer. Whitebrush grows well on all types of soils.

In one growing season whitebrush grows 3 to 5 feet tall. It is ready for herbicide treatment during the second growing season.

Two attempts were made to propagate whitebrush from crowns having a portion of stem and root. The crowns were lifted with a bulldozer and trimmed with an axe. In one case the crowns were dug in the fall and transplanted immediately with good success. In the other, the crowns were dug in a hot, dry period in the summer. Most of the crowns probably dried out excessively in transit (about 179 miles) because few became established.

Winged Elm. Winged elm (*Ulmus alata* Michx.) is propagated in the field nursery by transplanting seedlings from the greenhouse. Winged elm seeds (actually a samara) are collected when mature in February or early March before the leaves emerge. Seeds are either shaken or stripped off the branches onto a tarpaulin spread under the tree. The seeds are then stored in plastic bags at 35°F for as long as 6 months; usually germination decreases progressively thereafter. Normally, winged elm seed are not usable after 1 year.

Seeds are distributed onto sandy loam soil in flats and covered with 0.25 inch of sand. After about 6 weeks, the seedlings are 2 inches tall and are transplanted into 2- x 2-inch peat moss pots. After another 8 weeks, when plants are 6 to 12 inches tall, they can be transplanted into the nursery. Best results are obtained by planting the seeds immediately after harvest and transplanting the seedlings to the field in May. Winged elm does best on the heavier clay loam soil.

Winged elm seedlings (like other seedlings) are planted at 2-foot intervals in rows 10 feet apart. Winged elm is usually sprayed the year following transplanting in the field.

Greenbrier. Saw greenbrier (*Smilax bona-nox* L.) is propagated by transplanting sections of the rhizomes. Best results are obtained by transplanting in January to March. A native stand is mowed, and the rhizomes are brought to the soil surface by plowing. The rhizomes are chopped into segments 3 to 4 inches long. The rhizome pieces can be stored in wet peat moss in a cooler for at least 2 months, but the percentage of survival is highest when transplanted as soon as possible after digging. The rhizome segments are planted with a tractor-mounted transplanter 2 inches deep at 1-foot intervals in rows 10 feet apart. Shoots are produced sooner if planted with a green stem segment protruding from the soil than if roots alone are buried in the soil.

Greenbrier grows erratically and slowly. One month is usually required before most rhizomes produce shoots. Plant segments continue to produce shoots throughout the growing season and can be sprayed the year following planting.

Loblolly Pine. One-year-old seedlings of loblolly pine (*Pinus taeda* L.) were purchased from the Texas Forest Service and transplanted into the nursery. December and January are the preferred months for transplanting. Loblolly pine did not grow well in the clay soils of the nursery. Most seedlings died in heavy soils that received excessive amounts of runoff water from the concrete runways.

However, good survival occurred on the better drained soils, and plants grew rapidly enough to permit treatment 1 year after transplanting.

The seedlings are readily available from the Texas Forest Service at reasonable cost; consequently, no attempts were made to propagate the plants from seed.

Yaupon. Yaupon (*Ilex vomitoria* Ait.) was established in the nursery from seedlings purchased from commercial nurseries in the summers of 1964 and 1965. This method was not satisfactory. In 1964 fewer than 5 percent of the transplants became established, even though the seedlings were in excellent condition at the time of planting and weather conditions were favorable for establishment. In 1965, conditions for establishment of the plants were again favorable, but only about 15 percent of the plants survived.

Yaupon seed has a 1- to 2-year dormancy period, and no method has yet been found to break this dormancy, except by special planting techniques. Yaupon can also be propagated vegetatively from cuttings, but 1 or 2 years are required before the plants can be placed in the field.

Green and Arizona Ash. Green ash (*Fraxinus pennsylvanica* Marsh.) and Arizona ash (*F. velutina* Torr.) plants, about 2 feet tall, were transplanted in May 1969. By December, about 75 percent had survived. By 1970, excellent survival of Arizona ash was noted, but most of the green ash had died.

Planting Methods

Planting methods have varied during the development of the nursery for the different species. The trend is toward a more mechanized operation.

Seeds of honey mesquite and huisache are seeded with a modified Planet Junior (Figure 3). The planter consists of a 2-gallon hopper attached to the frame of a tractor. A chain drive attached to the axle of the tractor drives an agitator in the bottom of the hopper to ensure uniform flow of the seed through the plate opening. Modified planting plates regulate dispersal of the seed. One row is planted at a time since the rows are 10 feet apart. The seeds are planted about 3 inches apart and 1 inch deep.

Greenhouse transplants, Macartney rose roots, and live oak acorns are planted with a tractor-mounted transplanter (Figure 9). Furrows are opened, the plants or plant parts are inserted by hand into the soil, and the furrows are closed in one operation. Seedlings are spaced 2 feet apart. Honey mesquite, huisache, whitebrush, and winged elm are planted in 2- x 2-inch or Jiffy peat moss pots when 6 to 12 inches tall. The entire pot is placed in the soil so that the top of the pot is about 1 inch below the surface of the soil. One row is planted at a time. Bare-root plants of yaupon, ash, live oak, winged elm, loblolly pine, and others are also planted with the same transplanter (Figure 9).

Whitebrush crowns are planted by opening a furrow in the row and planting the crowns by hand. The plants are then watered and the furrows are closed with a disc.

Weed Control

Weed control is one of the major problems in the maintenance of the nursery. Weed control of herbaceous vegetation is necessary to remove competition with the woody seedlings for moisture, light, nutrients, and space. The amount of weed control required depends upon the competitive ability of each woody species and on the type and vigor of competing herbaceous weeds.

After seeding in a well-prepared seedbed in the spring, honey mesquite and huisache seedlings are usually large enough to be cultivated within 2 weeks. Shields are used on the inside cultivator shoes to prevent burying the plants. Subsequent cultivations between the rows can be made as necessary to keep the weeds out. Weeds in the rows can be controlled (Figure 7) with 2 to 3 pounds per acre of simazine applied broadcast or in a band after the plants are 2 to 6 inches tall.

Macartney rose roots, greenbrier rhizomes, and live oak acorns can be sprayed immediately after planting with 2 to 3 pounds per acre of simazine. Weed control is maintained for 3 to 6 months, then the plants are cultivated and disc-harrowed for about 6 to 10 months until the plants become about 3 feet tall.

Transplanted seedlings of yaupon, winged elm, loblolly pine, or ash have not been sprayed with simazine. Whitebrush on a sandy loam soil was killed with an 8 + 2-pound-per-acre rate of simazine + paraquat sprayed directly on the soil.

Hand hoeing has been employed in the past to control weeds in the rows, but this has become prohibitively expensive on a large scale.

Johnsongrass is a serious problem in some areas. Johnsongrass is controlled at the nursery with dalapon by frequent spot treatments at a 5-pound-per-acre rate. When johnsongrass becomes too dense, cultivation is used to control it. Glyphosate has also been used to control johnsongrass as a broadcast spray, before woody plants or forage crops are established.

Age of Plants for Treatments

The primary objective in growing plants in the nursery is to obtain plants of the proper vegetative size and physiological status to give responses to herbicides similar to those of natural stands. It is most desirable to spray plants when they are 3 to 5 feet tall.

Huisache grows rapidly enough to be sprayed in the fall of the same year that it is planted. Honey mesquite, whitebrush, Macartney rose, winged elm, loblolly pine, yaupon, and ash can be sprayed the year after planting. Live oak and greenbrier are usually sprayed when 2 years old. The plants, with the exception of loblolly pine, can be mowed with a rotary mower and allowed to grow back if they become too tall for treatment. Trees, 5 to 15 feet in height, can be treated with granular herbicides, basal treatments, or a tractor-mounted sprayer described in the next section.

Equipment and Techniques for Applying Herbicides

Hand-carried and tractor-mounted sprayers are used in the nursery. The hand-carried sprayer is used primarily for spot spraying and for experiments conducted where the tractor cannot be driven. The hand-carried sprayer consists of a 3.5 gallon stainless steel compressed air tank attached either to a single-nozzle or a three-nozzle boom which sprays a 5-foot wide swath.

Most of the spraying is done with a tractor-mounted sprayer, described by Flynt et al. (8) and shown in Figure 10. It consists of a spraying platform, windshields, and two compressed air-operated three-nozzle booms that spray a 5-foot swath each. It is used to spray brush up to 5 feet tall. The tractor-mounted sprayer is much faster to operate, eliminates carrying of equipment, can be used in winds up to 10 miles per hour (mph) and gives a more accurate distribution of chemicals than the hand-carried sprayer. Sprays are usually applied at a volume of 20 gallons per acre. Various herbicide rates were used to determine minimum rates that effectively control each species.

Another tractor-mounted boom sprayer described by Flynt et al. (8) is used on large brush up to 15 feet tall (Figure 11). Huisache and Macartney rose have been sprayed using this device. Spray volumes of 10 or 20 gallons per acre are generally applied.

Methods of Herbicide Evaluation

Each herbicide-treated plot is usually 5 feet wide by 20 feet long or longer with a minimum of 10 plants per plot. Plants in a 2- to 3-foot increment at either end of the plot are not rated. Generally, a randomized block design is used with four replications.

Visual ratings are made by estimating percent defoliation within the same growing season after treatment to indicate initial activity of the treatment. After 1 year, control ratings are based on visual estimates of canopy reduction and/or percentage of plant population killed. A completely defoliated plant 1 year after treatment is considered dead. Honey mesquite, huisache, live oak, Macartney rose, winged elm, greenbrier, loblolly pine, and yaupon were rated for the percentage of canopy reduction. Whitebrush was rated both for percentage of canopy reduction and for plants killed. Whitebrush readily resprouts if not killed and can become reestablished from sprouts within 2 to 4 years; consequently, the percentage of plants killed is important.

RESULTS AND DISCUSSION

Honey Mesquite

New Herbicides and Date of Application. Comparison of broadcast sprays of the 2-ethylhexyl ester of 2,4,5-T and the potassium salt of picloram were made in the nursery on honey mesquite (Table 1). Picloram was a new compound being evaluated for brush control in 1964. 2,4,5-T was slightly more effective than picloram in controlling honey mesquite at most dates of application. Picloram, however, was generally more effective than 2,4,5-T at three rates of treatment and five dates of application in 1965 (Table 2). Treatments of both picloram and 2,4,5-T made in June and July were more effective than those made in mid-April 1965, whereas treatments made in May 1964 were slightly more effective than June and July applications (Table 1). At comparable rates, picloram alone was superior to mixtures of paraquat + 2,4,5-T (1:1) or paraquat + picloram at most dates of application, particularly after mid-April (Table 2). These results agree with control data from field studies in which paraquat reduced (antagonistic) the effect of picloram on some woody species (1). Possibly, the paraquat injured the translocating mechanism in the leaves, before 2,4,5-T or picloram could be translocated to the base of the plant.

Further evaluation in 1967 (Table 3) indicated excellent defoliation or canopy reduction of honey mesquite 1 year after treatment in June and July using picloram, 2,4,5-T, or combinations of picloram + 2,4,5-T (93 to 100 percent canopy reduction for all treatments and rates). The picloram + 2,4,5-T combination has since been proven effective in the field (15). These studies also show that foliar sprays of herbicides applied to honey mesquite are usually most effective during May and June under South-Central Texas conditions. Numerous field studies have shown foliar sprays of 2,4,5-T, picloram, or picloram + 2,4,5-T to be most effective on honey mesquite 40 to 90 days after bud opening (May 15 to July 10) and relatively ineffective at other times of the year (14, 15). The nursery data agree with long-term data from field research. However, much is yet to be learned about the variable response of honey mesquite to herbicides, as indicated by the results of the 1964 and 1965 treatments compared to those made in 1966.

In 1965, several new herbicides were evaluated on honey mesquite and other woody species (Table 4). Picloram at 2 pounds per acre was more effective than sodium and potassium azide, bromacil, amizine, pyriclor, paraquat + amitrole, picloram + pyriclor, or picloram + amitrole at comparable rates. In fact, picloram at 2 pounds per acre was more effective than 8 pounds per acre of most other herbicides, except the 4 + 4 pounds per acre mixture of picloram + amitrole. Thus, 2,4,5-T and picloram were the two most effective herbicides of those evaluated for controlling honey mesquite.

Spray Volume. The volume of carrier in herbicide sprays sometimes influences effectiveness of treatment (Table 5). The 2-ethylhexyl ester of 2,4,5-T at 1/2 pound per acre was sprayed on honey mesquite in an oil-water carrier (1:3) at volumes equivalent to 4, 20, and 100 gallons per acre. A three-nozzle hand-carried boom attached to a 3-gallon compressed air sprayer was used. Teejet nozzle tips No. 800067, 8001, and 8015 were used to obtain the 4, 20, and 100 gallons per acre, respectively. Herbicide applied at 20 gallons per acre reduced the canopy more than when applied at 4 or 100 gallons per acre. Compared to 20 gallons per acre, 4 gallons per acre may have given insufficient coverage of the leaves and stem surfaces, whereas 100 gallons per acre may have resulted in loss of the herbicide from plant surfaces from excessive runoff. Further studies in the laboratory and field are needed to clarify the role of spray volume in brush control.

Surfactants. Comparisons of surfactants added to either picloram (K salt) or the ester or amine of 2,4,5-T at 1 pound per acre each were made on honey mesquite and live oak (Table 6). No consistent trends were noted among surfactants, regardless of herbicide used. Similarly, all three herbicides were about equally effective statistically on honey mesquite, although picloram tended to be most effective. No comparison was made between herbicides with and without surfactant.

Several surfactants were added at 1% volume/volume (v/v) to spray solutions of the triethylamine salts of picloram + 2,4,5-T (1:1) (M-3252X) on honey mesquite (Table 7). The M-3252X formulation was an experimental herbicide containing no surfactants. Renex 36 was the only surfactant that increased the activity of M-3252X statistically, although several surfactants appeared to enhance the activity of M-3252X. Canopy reduction of honey mesquite by the commercial formulation of picloram + 2,4,5-T was not significantly different from any other treatment, including the untreated plots. Unfortunately, the late August treatment appeared to minimize treatment differences. The commercial herbicide formulations contain emulsifiers and surfactants which are intended to improve their herbicidal properties so additional surfactants may not have added benefit.

An additional experiment in 1968 on honey mesquite at a more favorable time of year (June) for herbicide activity indicated that all but one surfactant increased the activity of M-3252X (Table 8). However, none of the surfactant + M-3252X mixtures were superior to the commercial formulations of picloram + 2,4,5-T (Tordon 225). DMSO (dimethyl sulfoxide), alone or with surfactants, did not appear to improve the effectiveness of M-3252X. Therefore, in this experiment, surfactants added at 1 percent (v/v) to a herbicide (M-3252X) without surfactant, effectively increased herbicidal activity (canopy reduction) on honey mesquite, but none was superior to the commercial formulation.

Herbicide Carriers. No differences occurred in canopy reduction of honey mesquite when water or diesel oil carriers at 20 gallons per acre were used with the 2-ethylhexyl ester of 2,4,5-T (Table 9). Herbicide 2,4,5-T at 1 pound per acre applied in diesel oil-water carriers at ratios of 1:3, 1:9, and 1:18 was as effective as diesel oil or water carrier alone. When applied at 1/2 pound per acre, 2,4,5-T was ineffective regardless of carrier. Apparently, at the lower rate there was insufficient emulsifier from the herbicide formulation to form a stable emulsion.

Herbicide Formulation and Additives. Experiments in 1968 indicated that the triethylamine salts of picloram + 2,4,5-T (commercial formulation) were generally superior to comparable rates of the isooctyl ester of picloram (M-3142) or 1:1 mixtures of the isooctyl ester of picloram plus the propylene glycol isobutyl ether esters of 2,4,5-T (M-3346)

(Table 10). The commercial preparation of picloram + 2,4,5-T was equally effective when applied in water or oil-water carriers. Type of surfactant used with all herbicides did not appear to influence control.

The 2-ethylhexyl ester of 2,4,5-T gave good canopy reduction of honey mesquite with most additives (Table 11). The ester of 2,4,5-T applied in water; diesel oil; diesel oil-water emulsion carriers; or 5 percent glycerol propylene glycol, and C-56 added to water carriers gave equal results. The triethylamine salt of 2,4,5-T also gave good honey mesquite control considering the late date of treatment (August). The additives ammonium thiocyanate (NH_4SCN) or hexafluoroacetone appeared to reduce activity of 2,4,5-T. The 2,4,5-T + dicamba mixture was less effective than 2,4,5-T alone. Two amine formulations of 2,4-D were ineffective.

Further work in 1965 again indicated that the addition of NH_4SCN did not improve 2,4,5-T effectiveness (Table 12). An oil-water emulsion (1:3) carrier was used to a spray volume of 20 gallons per acre. Ammonium thocyanate was added at 1 part to 20 parts herbicide solution (1:20).

Based on earlier research, a large number of herbicide formulations and additives were investigated in 1967 to define the most effective preparations for honey mesquite control (Table 13). The triisopropanol amine salts of picloram + 2,4,5-T (1:1), the ester of 2,4,5-T + 0.1 percent G-3300, and picloram + 2.0 percent ACL 500 at 1/2 pound per acre were among the most effective treatments. Control in general was poor and no consistent trends were apparent regardless of herbicide formulation or additive.

Ethephon [(2-cholorethyl)phosphonic acid] was not effective as a herbicide on honey mesquite and did not improve the activity of picloram, 2,4,5-T, or a 1:1 mixture of picloram+ 2,4,5-T, when added at 2 or 4 pounds per acre under the conditions of this study (Table 14).

Huisache

New Herbicides and Date of Application. A June 1966 treatment with picloram, the ester of 2,4,5-T, or mixtures of the two at 2 and 4 pounds per acre resulted in a high percentage canopy reduction of huisache (Table 15). The amine salt of 2,4,5-T, however, was ineffective. The K salt of picloram also caused effective canopy reduction of huisache when applied in the fall of 1966 and spring and summer of 1967 at 1 and 2 pounds per acre (Table 16). The isooctyl ester of picloram was effective in July and October, but not in May. The amine salts or esters of 2,4,5-T were generally ineffective, but combinations of picloram + 2,4,5-T were generally effective.

These data from the nursery agree with results of applications to huisache in wild stands using foliar sprays from ground or aerial equipment. Picloram rates in field applications could be reduced by adding comparable amounts of 2,4,5-T without decreasing effectiveness. Spring or fall treatments were both effective (4, 13).

Live Oak

New Herbicides and Date of Application. Best control of live oak was obtained with picloram at 2 and 4 pounds per acre applied in June and September 1965 (Table 17). The bromacil + paraquat mixture at 2 + 2 and 4 + 4 pounds per acre was also very effective, especially when applied in September. All herbicides applied in April were less effective than June or September treatments. The 2,4,5-T treatments were relatively ineffective on live oak. Dicamba and paraquat were intermediate in herbicidal activity.

Mixtures of picloram + 2,4,5-T gave results similar to picloram alone at comparable rates when applied to live oak (Table 15). When several new herbicides were investigated, bromacil, in addition to picloram, effectively controlled live oak (Table 4).

The nursery data agree with field data which showed that picloram or bromacil effectively controlled live oak when applied in the spring or fall in South Texas (3). Also, the picloram + 2,4,5-T mixture was effective, while 2,4-D and 2,4,5-T alone were ineffective. Aerial application studies produced similar results (2).

Spray volume. Herbicide 2,4,5-T at 2 pounds per acre appeared more effective on live oak when sprayed in diesel oil-water (1:3) carrier at 20 and 100 gallons per acre than at 4 gallons per acre (Table 5). Canopy reduction after application of the higher spray volumes was 64 percent or more, compared to only 44 percent at the 4 gallons per acre volume. The higher spray volumes may be more effective in thoroughly wetting and penetrating the heavy cuticle and "leather type" leaves of live oak than low spray volumes.

Multiple treatment. Control of most live oak was poor, regardless of treatment, when single or repeated herbicide applications were made

(Table 18). Under the conditions of this experiment, there appeared to be no advantage of retreatment with another herbicide 2 days after original treatment except for the application of 2,4,5-T following paraquat. Further studies are needed to determine if enhanced herbicidal activity can be derived from multiple herbicide treatments, either in a relatively short time interval (hours to several days) between herbicide treatments, or in longer annual or biennial treatments.

Surfactants. Data in Table 6 indicate no consistant advantage of any one surfactant when combined at equal rates with picloram or the ester or amine formulation of 2,4,5-T. All treatments were ineffective. No comparison was made of herbicides without surfactants.

Significant increases in canopy reduction of live oak were obtained when several surfactants were added at 1 percent (v/v) of total spray solution to the experimental herbicide M-3252X (containing picloram + 2,4,5-T, 1:1) without surfactant (Table 7). Renex 30, 31, and 36; Tween 21, 80, and 85; and ACL 574 and 578 all enhanced herbicidal activity of M-3252X. The commercial formulation of picloram + 2,4,5-T (Tordon 225), although relatively ineffective, was more effective than M-3252X without a surfactant.

In a 1967 experiment, DMSO, X-77, ACL 500, or G-3300 were added to various formulations of picloram, 2,4,5-T, and 2,4-D (Table 19). Except for the 2-pound-per-acre rate of picloram + 1 percent X-77, most treatments were ineffective on live oak. Treatments in 1968 (Table 20) indicated that none of the M-3252X + surfactant treatments, alone or with DMSO, were better than the commercial Tordon 225.

Herbicide Carriers. Diesel oil as a spray carrier for 2,4,5-T was slightly superior to water for live oak control at 1 pound per acre (Table 9). Diesel oil-water carriers gave results similar to water as a spray carrier when 2,4,5-T was applied at 1 pound per acre. At 2 pounds per acre of 2,4,5-T, the 1:3 and 1:9 diesel oil:water emulsions were less effective than other carriers. In this experiment, all treatments of 2,4,5-T were ineffective on live oak. Studies on live oak in 1967 (Table 21) indicated that water and diesel oil-water (1:3) carriers were about equally effective with the triethylamine salts of picloram + 2,4,5-T (1:1), and with the K salt of picloram + 2-ethylhexyl ester of 2,4,5-T (1:1).

The isooctyl ester of picloram was generally most effective when applied in oil carriers than in oil-water carriers (Table 22), possibly due to the poor emulsification properties of the ester. The isooctyl ester applied in oil, the triethylamine salts of picloram + 2,4,5-T, and the K salt of picloram alone were about equally and only moderately effective in canopy reduction of live oak. Various oil-water carriers and/or surfactants with picloram + 2,4,5-T or the K salt of picloram were about equally effective to water carrier alone. In an additional experiment (Table 23), the triethylamine salts of picloram + 2,4,5-T (1:1) in water carrier combined with surfactant Renex 30 reduced the canopy of live oak more than several other treatments. However, little difference occurred among most treatments, regardless of carrier and surfactant used. Most treatments were ineffective.

Herbicide Formulations and Additives. No significant differences in live oak control were found between treatments using various formulations, carriers, and additives with 2,4,5-T. Several carriers, particularly diesel oil, caused more defoliation than water, regardless of herbicide used (Table 11). Canopy reduction of live oak from most 2,4-D and 2,4,5-T treatments was relatively poor.

Ammonium thiocyanate (Table 12) added to 2,4,5-T (1:20) did not increase the canopy reduction of live oak compared to 2,4,5-T alone in water carriers. However, X-77, but not DMSO, progressively increased the effectiveness of picloram at 1 pound per acre on live oak as X-77 rates were increased from 0 to 10 percent (v/v) (Table 24); no consistent trend occurred in the 2,4,5-T or paraquat treatments.

Macartney Rose

New Herbicides and Date of Application. Initial comparisons indicated that picloram was more effective for Macartney rose control than 2,4,5-T (Table 1). One pound per acre of picloram (K salt) gave 100, 75, and 95 percent canopy reduction in May, June, and July 1964 treatments, respectively. Picloram sprayed at 4 pounds per acre killed all plants at all dates of application.

In 1966 (Table 25), early May treatments were more effective than mid- or late May treatments. All Macartney rose was killed at rates of 1/2, 1, and 2 pounds per acre of picloram (K salt) on May 9. Optimum treatment date for 2,4-D (dimethylamine salt) was also in early May, but 2 pounds per acre were required for effective canopy reduction. Picloram was more effective than 2,4-D at comparable rates at all dates of application. Combinations of picloram + 2,4-D (1:3) were effective during May at 1/4 + 3/4 and 1/2 + 1-1/2 pounds per acre. Combining picloram and 2,4-D reduced the total amount of the more persistent and expensive picloram required to maintain Macartney rose control.

In 1967, treatments were applied in May, June, and July (Table 26). Results were similar to studies conducted in 1966. Picloram (K salt) effectively controlled Macartney rose at all rates in May, but a 1/2 pound per acre rate declined in effectiveness when applied in July. The alkanol amine salt of 2,4-D was not very effective at any rate or date of application. When picloram and 2,4-D (1:3) were combined at 1/4 + 3/4 pound per acre, effective control was obtained in May. At 1/2 + 1-1/2 pounds per acre of picloram + 2,4-D, effective control of Macartney rose occurred at all treatment dates.

In 1965, several new herbicides were compared with picloram for Macartney rose control (Table 4). None were effective except picloram (K salt) or combinations of other herbicides with picloram. Herbicides ineffective on Macartney rose included sodium and potassium azide, bromacil, amizine, pyriclor, and paraquat + amitrole.

Data obtained from field studies also indicated that picloram was superior to other herbicides investigated for Macartney rose control (13). Picloram (spray or granule) effectively controlled Macartney rose when applied throughout the year, except during the hot dry summer months (July and August). Although 2,4-D is usually the recommended treatment for Macartney rose, data from these and other studies demonstrate that picloram, picloram + 2,4-D, or picloram + 2,4,5-T provide superior control compared to 2,4-D alone (5, 12).

Spray Volume. At 2 pounds per acre, 2,4-D was slightly more effective on Macartney rose when sprayed in diesel oil-water (1:3) carrier at 20 gallons per acre than at 4 or 100 gallons per acre (Table 5). Apparently 20 gallons per acre gave adequate coverage of the foliage without excessive runoff. Canopy reduction for all treatments, however, was not outstanding.

Surfactants. Picloram at 1 pound per acre with 1 percent X-77 surfactant reduced the canopy of Macartney rose 96 percent (Table 27). The 2 pound-per-acre rate of picloram, either with X-77 or DMSO (1 percent), killed all or almost all Macartney rose. Picloram + ester of 2,4-D (1:1) with DMSO (1 percent) at a total of 1 and 2 pounds per acre killed most stem tissue. Two pounds per acre of the dimethyltridecylamine salt of 2,4-D was also highly effective on Macartney rose, but when combined with equal rates of picloram, control was reduced. The reason for this is not clear. Surfactant ACL 500 at 2 percent (v/v) appeared to enhance the activity of the 1/2 pound-per-acre rate of picloram compared to 1 percent (v/v). However, most other combinations of surfactants, additives, and 2,4-D formulations were ineffective. No comparisons were made of herbicides with and without surfactants.

In other studies (Table 28), control of Macartney rose was excellent when treated with 1 pound per acre picloram plus equal rates of several surfactants. All 2,4-D treatments were ineffective regardless of surfactant added.

Herbicide Carriers. Regardless of carrier, control of Macartney rose was excellent when picloram + 2,4-D (1:2) sprays at 1, 2, or 4 pounds per acre were applied in water or diesel oil-water (1:3) carriers (Table 29). One formulation was the triethylamine salts of picloram + 2,4-D; the other, the potassium salt of picloram + the 2-ethylhexyl ester of 2,4-D.

Herbicide Formulations and Additives. Most formulations of 2,4-D and 2,4,5-T, with and without various additives and carriers, were about equally effective on Macartney rose (Table 11). Almost all treatments of the ester of 2,4,5-T were more effective than the triethylamine formulation of 2,4,5-T.

Ammonium thiocyanate (NH_4SCN), with 2,4,5-T (1:20) (Table 11) or 2,4-D (1:20) (Table 12), did not enhance herbicide phytotoxicity on Macartney rose. However, X-77 at most concentrations, but not DMSO, increased the effectiveness of picloram at 1/4 and 1/2 pound per acre on Macartney rose (Table 30). The activity of 2,4-D or paraquat, however, was not increased by various rates of X-77 or DMSO. Similar results were obtained from June (Table 30) and August 1966 (Table 31) treatments.

Whitebrush

New Herbicides and Date of Application. In 1964, nursery studies were initiated on control of whitebrush, a problem woody weed on rangelands of the Central Basin and South Texas Plains (Table 1). Comparisons of picloram and the recommended treatment, MCPA, indicated that picloram had potential for whitebrush control. A canopy reduction of 92 percent was obtained with the K salt of picloram at 4 pounds per acre applied in May. June and July treatments of picloram were progressively less effective. Comparable rates of MCPA were not as effective as picloram when applied in May, but were in June and July.

Further research indicated excellent kill of whitebrush with picloram at 1 pound per acre when applied at three dates in April 1965 (Table 32). MCPA reduced the canopy growth more than 80 percent, but killed few plants. The addition of amitrole-T at 1/2 and 1 pound per acre to 1/2 pound per acre of picloram appeared to increase percentage kill of whitebrush, over that obtained with picloram alone; however, no differences were indicated statistically (Table 33). Mixtures of picloram with 2,4,5-T or 2,4-D, DMSO, or surfactants at comparable rates did not increase the effectiveness of picloram on whitebrush (Tables 34 and 35). The addition of DSMA appeared to reduce (antagonistic) the effectiveness of 2,4-D on whitebrush (Table 35).

A variety of phenoxy herbicides were compared to new herbicides, such as picloram, pyriclor, and karbutilate, for whitebrush control September 1966 (Table 36). Results indicated MCPA, MCPB, 2,4-D, and picloram were most effective, with mecoprop and 2,4-DB of intermediate effectiveness. The susceptibility of whitebrush to herbicides is variable, due to differences in growth conditions and physiological state of the plant. Whitebrush with a full complement of leaves and open flowers, growing on soil with abundant moisture and favorable air temperature, is much more susceptible to herbicides than those defoliated and under drought stress. As indicated from the results shown in Table 36, whitebrush possessed full foliage and was growing under favorable environment. Some of the poor results shown in Tables 34 and 35 were from experiments conducted under less favorable conditions.

Field data from natural stands of whitebrush also indicated that picloram was more effective than phenoxy herbicides for controlling whitebrush (11). September and October applications of picloram sprays were more effective than May applications. Picloram, however, was ineffective at rates up to 4 pounds per acre, when the soil was dry and air temperatures were high and when whitebrush was naturally defoliated. In another study, Meyer and Riley (10) found granules and sprays of picloram most effective on whitebrush when applied during the cooler months of the year, particularly when application was soon followed by rainfall. Whitebrush kill increased with increasing rate (1, 2, and 4 pounds per acre) of picloram.

Spray Volume. No differences in canopy reduction resulted when whitebrush was treated with MCPA at 1 pound per acre in spray volumes of 4, 20, or 100 gallons per acre (Table 5).

Herbicide Formulations, Surfactants, and Additives. DMSO or X-77 had little influence on the herbicidal properties of picloram at 1/2 pound per acre (Table 37). The isooctyl ester of picloram (1/2 pound per acre) killed no whitebrush. Diesel oil-water (1:10) carrier, compared to water carrier, appeared to improve the effectiveness of 1/2 pound per acre picloram on whitebrush. Picloram + X-77 surfactant at 1 and 2 pounds per acre was more effective than equivalent rates of the 1:1 mixtures of the triethylamine salts of picloram + 2,4,5-T + X-77 or picloram (K salt) + 2,4,5-T (2-ethylhexyl ester). A mixture of 2,4-D and picloram (1:2), like the triisopropanolamine salts (Tordon 212), was no more effective than picloram alone.

The dimethyltridecylamine formulation of 2,4-D was more effective on whitebrush than 2,4,5-T ester (Table 11). Data in Table 38 showed no consistent differences in whitebrush kill when X-77, DMSO, or diesel oil were added at various concentrations to MCPA or picloram. Ammonium thiocyanate added to MCPA (1:20 NH_4SCN:MCPA) did not enhance MCPA phytotoxicity on whitebrush (Table 12).

Winged Elm

New Herbicides and Date of Application. Winged elm was effectively controlled with 4 pounds per acre of the potassium salt of picloram but was not controlled at 1 pound per acre in May, June, and July applications in 1964 (Table 1). Applications in 1965 indicated April treatment of picloram at 1 and 2 pounds per acre gave excellent control, whereas later treatments in June tended to decline in effectiveness (Table 39). Paraquat and 2,4,5-T were not very effective at any rate or date of application. Picloram alone was more effective than 2,4,5-T or picloram + 2,4,5-T (1:1) when applied at two dates in May 1966 (Table 40). In other experiments to investigate new herbicides, picloram and bromacil proved more effective than 2,4,5-T, paraquat, or dicamba (Table 41). Similar results were obtained from studies established in June 1965 (Table 4), in which picloram at 2 pounds per acre killed all plants. Most picloram treatments in combination with amitrole or pyriclor were also effective, as was bromacil at 8 pounds per acre. Sodium and potassium azide, amizine, pyriclor, and paraquat + pyriclor were not effective. Lehman and Davis (9) also found picloram effective in wild stands, but found 2,4,5-T, dicamba and bromacil ineffective. The most effective treatment date for foliar sprays of picloram was late March or early April.

Spray Volume. Spray volume of 20 gallons per acre was more effective than 4 or 100 gallons per acre in an oil-water (1:3) carrier when used with 2 pounds per acre 2,4,5-T on winged elm (Table 5). Possibly, 20 gallons per acre gave better plant coverage than 4 gallons per acre, and the 100 gallon-per-acre sprays may have caused excessive runoff and loss of some of the 2,4,5-T from the foliage.

Herbicide Formulation and Additives. The addition of NH_4SCN did not enhance the herbicidal activity of 2,4,5-T on winged elm (Table 12).

In Oklahoma, Elwell (6) found picloram and picloram + 2,4,5-T more effective than 2,4,5-T alone for control of winged elm on rangeland. Herbicide 2,4,5-T alone was ineffective, but when NH_4SCN or amitrole was added to 2,4,5-T (1:1), the combination effectively controlled winged elm.

Greenbrier

New Herbicides and Date of Application. Picloram sprayed at 8 pounds per acre on June 30, 1965 was only moderately effective on greenbrier 1 year after treatment (Table 42). Picloram at 2, 4, and 8 pounds per acre applied on April 16 and 30 and June 8, 1965 was ineffective, as were dicamba, bromacil, paraquat, and 2,4,5-T.

A study established in 1967 indicated that picloram + amitrole was more effective when applied in October than in May, June, July, or August (Table 43). Herbicide 2,4,5-T was nearly as effective in July, August, and October treatments as the picloram + amitrole spray applied in October. In an experiment applied in June 1965, picloram + amitrole at 4 + 4 pounds per acre was as effective as 8 pounds per acre of picloram alone (Table 4). However, when lower rates (1 pound per acre) of picloram, picloram + 2,4,5-T, 2,4,5-T, or paraquat were applied alone or in several combinations in October 1967, poor control resulted (Table 18).

Surfactants and Carriers. Five of 12 surfactants combined with M-3252X, a 1:1 mixture of the triethylamine salts of picloram + 2,4,5-T, improved control of greenbrier over that obtained with M-3252X alone (Table 7). The more effective surfactants included Renex 30, 31, and 36, and Tween 21 and 85. The commercial preparation of the triethylamine salts of picloram + 2,4,5-T (Tordon 225) was intermediate in effect compared to most other herbicide treatments. As indicated in another experiment, higher rates (2 + 2 pounds per acre) of picloram + 2,4,5-T were required to improve canopy reduction of greenbrier, but complete kill was not obtained (Table 21).

Loblolly Pine

New Herbicides and Date of Application. Woody species of economic value also need to be evaluated for tolerance or susceptibility to herbicides, since many pine plantations or natural forested areas need weed control management. Data in Table 44 indicate that loblolly pine was only slightly damaged by 2,4,5-T, picloram, and dicamba at 1 pound per acre when treated in April or September 1965. Pines were heavily damaged by most rates of paraquat and by higher than 1-pound-per-acre rates of picloram and dicamba in April, June, and September applications.

CONCLUSIONS

Honey mesquite and huisache can be propagated from seed planted in greenhouse pots and later transplanted to the nursery or seeded directly in the nursery. Seed must be scarified to improve germination. Honey mesquite is scarified mechanically, while huisache germinates most readily after being soaked in concentrated H_2SO_4 for 1/2 to 1 hour. Whitebrush is propagated most easily from seed collected from the field. The seeds are germinated on sandy loam soil in greenhouse pots after watering and placing at 35°F for 3 days. After several months, the seedlings can be transplanted in the nursery. Live oak can be propagated either by planting acorns directly in the nursery in late fall, or from transplants from the greenhouse. Winged elm is propagated in the field nursery from seedling transplants from the greenhouse. Macartney rose and greenbrier are propagated by transplanting sections of roots and rhizomes, respectively, into the field nursery. Yaupon and loblolly pine are most successfully propagated by transplants (seedlings) purchased from commercial nurseries.

Conventional land preparation and weed control practices are required for best survival of the brush. Simazine has been used successfully for weed control in Macartney rose, greenbrier, and live oak plantings.

The most desirable time for herbicide treatment is after the plants are 3 to 5 feet tall and have been established in the nursery for 1 or more years. Four replications per herbicide treatment with 10 plants per replication were generally used.

Picloram proved to be one of the more effective herbicides studied on most woody species. Picloram alone was the most effective herbicide for whitebrush and winged elm control. Mixtures of picloram with other herbicides did not improve whitebrush control. In addition to picloram, bromacil + paraquat proved effective for live oak control. Picloram + 2,4,5-T (1:1) mixtures were effective against honey mesquite, live oak, Macartney rose, greenbrier, and huisache. Loblolly pine was only slightly damaged by 2,4,5-T, picloram, or dicamba at 1 pound per acre in early spring or fall. Paraquat, however, severely injured loblolly pine at most rates of application.

On most brush species, spray volume did not greatly influence the effectiveness of herbicide activity. Where differences did occur, the 2-ethylhexyl ester of 2,4,5-T was more effective on honey mesquite and winged elm when sprayed in a 1:3 oil-water carrier at 20 gallons per acre than at 4 or 100 gallons per acre. No differences were noted on live oak, Macartney rose, and whitebrush.

Some surfactants and diesel oil carriers enhanced the activity of a herbicide on some species and should be investigated further. Additives, such as NH_4SCN and DMSO, did not enhance the herbicidal activity of commercially prepared herbicides on most brush species. Some herbicide formulations also influenced brush control. For example, the ester of 2,4,5-T was more effective than the amine salt of 2,4,5-T on Macartney rose.

HERBICIDES USED

Picloram --- 4-amino-3,5,6-trichloropicolinic acid

2,4,5-T --- (2,4,5-trichlorophenoxy)acetic acid

Dicamba --- 3,6-dichloro-*o*-anisic acid

Bromacil --- 5-bromo-3-*sec*-butyl-6-methyluracil

Paraquat --- 1,1'-dimethyl-4,4'-bipyridinium ion

2,4-D --- (2,4-dichlorophenoxy)acetic acid

2,4-D Ethomeen T/15 --- tertiary amines having one fatty alkyl group (derived from various fatty sources having from 12 to 18 carbon atoms) and two polyoxyethylene groups attached to the nitrogen

$$RN<\begin{matrix}(CH_2CH_2O)_xH \\ (CH_2CH_2O)_yH\end{matrix}$$

DSMA --- disodium methanearsonate

Sodium azide

Potassium azide

Amizine --- aminotriazole + 2-chloro-4,6-bis(ethylamino)-*s*-triazine (1:3)

Simazine --- 2-chloro-4,6-bis(ethylamino)-*s*-triazine

Pyrichlor --- 2,3,5-trichloro-4-pyridinol

Amitrole --- 3-amino-*s*-triazole

MCPA --- [(4-chloro-*o*-tolyl)oxy]acetic acid

Mecoprop --- 2-[(4-chloro-*o*-tolyl)oxy]propionic acid

MCPB --- 4-[(4-chloro-*o*-tolyl)oxy]butyric acid

Dichlorprop --- 2-(2,4-dichlorophenoxy)propionic acid

2,4-DB --- 4-(2,4-dichlorophenoxy)butyric acid

Silvex --- 2-(2,4,5-trichlorophenoxy)propionic acid

Karbutilate --- *tert*-butylcarbamic acid ester with 3-(*m*-hydroxyphenyl)-
1,1-dimethylurea

Ethephon --- (2-chloroethyl)phosphonic acid

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

Alorac --- *z*-2,3,5,5-pentachloro-4-oxo-2-pentenoic acid

SURFACTANTS AND ADJUVANTS USED

Span 20 - sorbitan monolaurate (nonionic)

Renex 30 - polyoxyethylene (12) tridecyl ether (nonionic)

Tween 80 - polyoxyethylene (20) sorbitan monooleate (nonionic)

DMSO - dimethyl sulfoxide

Brij 96 - polyoxyethylene (10) oleyle ether (nonionic)

Renex 31 - polyoxyethylene (6) tridecyl ether (nonionic)

Renex 36 - polyoxyethylene (6) tridecyl ether (nonionic)

Tween 21 - polyoxyethylene sorbitan monolaurate (nonionic)

Tween 40 - polyoxyethylene (20) sorbitan monopalmitate (nonionic)

Tween 81 - polyoxyethylene (5) sorbitan monooleate (nonionic)

Tween 85 - polyoxyethylene (20) sorbitan trioleate (nonionic)

Atlox 209 - blended surfactants (ICI United States, Inc.) (nonionic)

ACL 574 - blended surfactants (ICI United States, Inc.) (nonionic)

ACL 577 - blended surfactants (ICI United States, Inc.) (nonionic)

ACL 578 - blended surfactants (ICI United States, Inc.) (nonionic)

X-77 - alkylarylpolyoxyethylene glycols, free fatty acids, isopropanol (nonionic)

AL-411A - polyoxyethylene sorbitol esters

ACL 500 - blended surfactants of straight chain polydyric alcohols 3 to 6 carbon atoms in length (ICI United States, Inc.) (nonionic)

G-3300 - amine salts of alkylaryl sulfonate (ionic)

Myrij 45 - polyoxyethylene stearate (nonionic)

M-3349 - Dow Chemical Company emulsifier for oil:water mixtures

Mentor 28 - nonphytotoxic oil

Naphtha - flammable, volatile oil - fraction between gasoline and kerosene

S.S 100 - nonphytotoxic oil

SX 4029 - nonphytotoxic oil

NH_4SCN - ammonium thiocyanate

Diesel oil

Glycerol

Propylene glycol

C-56

Hexafluoroacetone

Hexaflurate - potassium hexafluoroarsenate (TD-480)

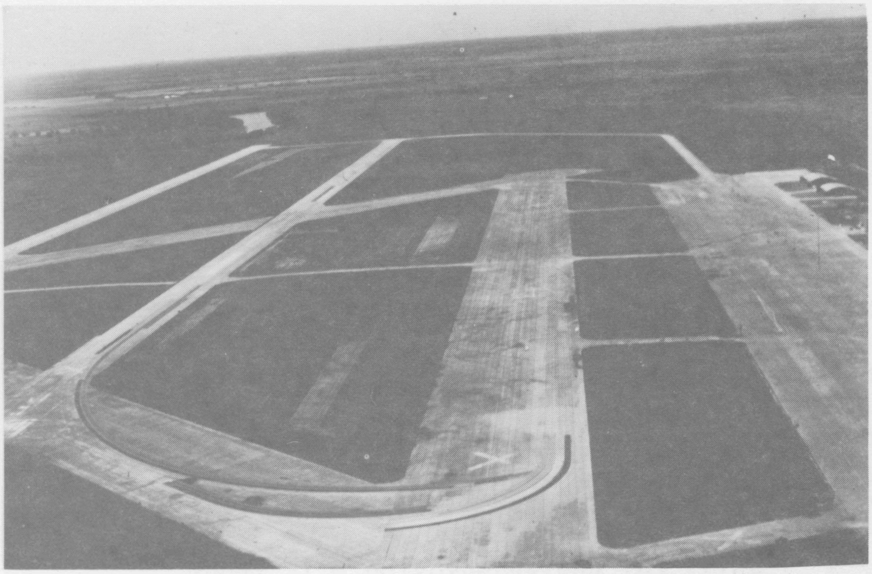

Figure 1. Field nursery at the Texas A&M Research and Extension Center, Bryan, Texas.

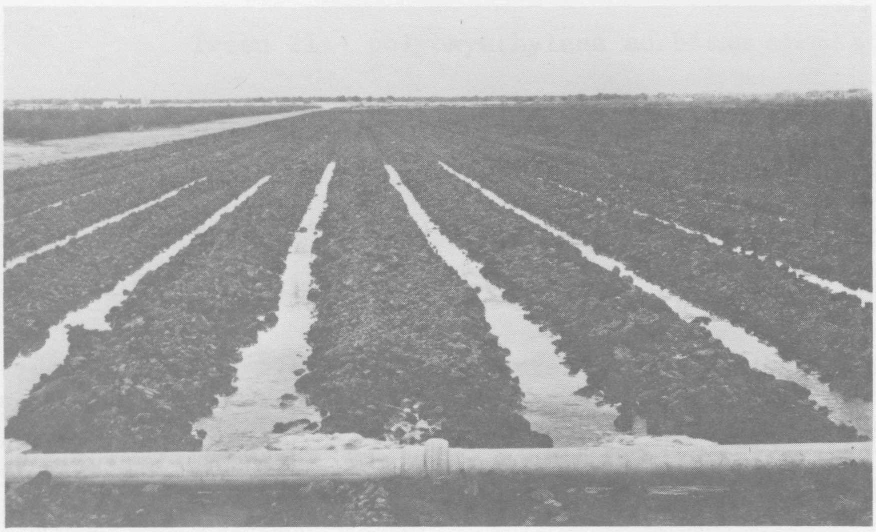

Figure 2. Flood irrigation of field recently planted with mesquite seed.

Figure 3. Tractor-mounted modified Planet Junior used to plant honey mesquite and huisache seed.

Figure 4. Direct seeding of honey mesquite seed in rows spaced 10 feet apart.

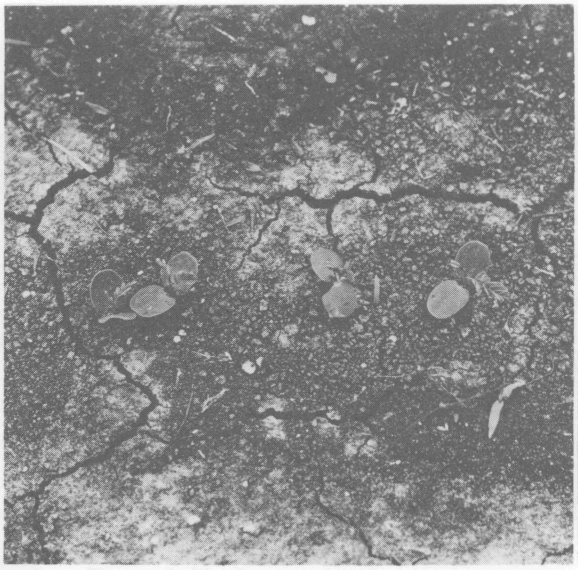

Figure 5. Honey mesquite seedlings 2 weeks after planting.

Figure 6. Huisache showing tall, dense growth (top) 1 year and (bottom) 2 years after planting.

Figure 7. Weed control in live oak rows (cultivation in center; 3 pounds per acre simazine at right).

Figure 8. Transplanting of greenhouse-grown whitebrush in the nursery.

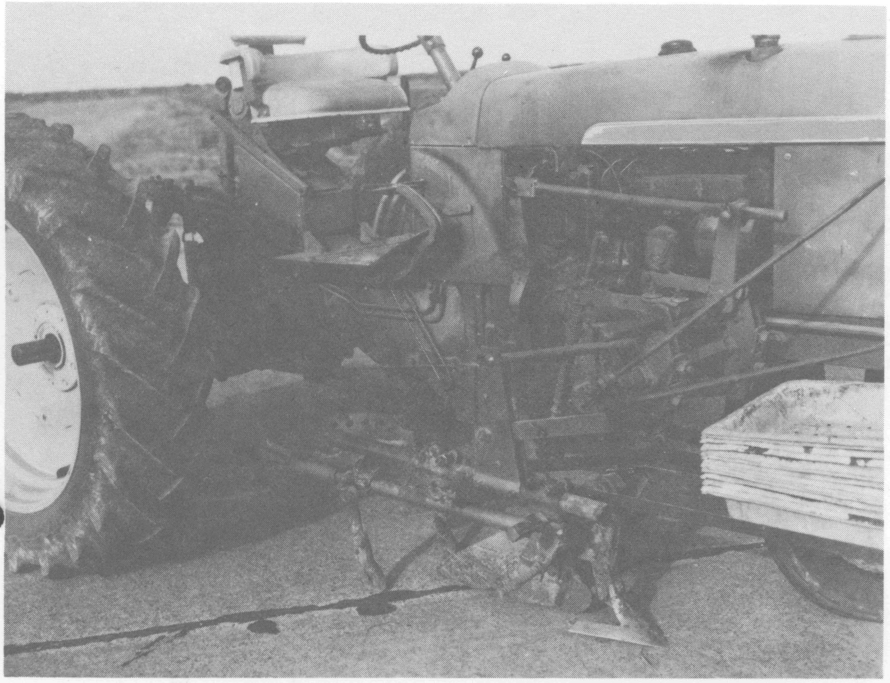

Figure 9. Tractor-mounted transplanting device used to plant oak acorns, established seedlings (bare-rooted or in pots), and vegetative parts of plants.

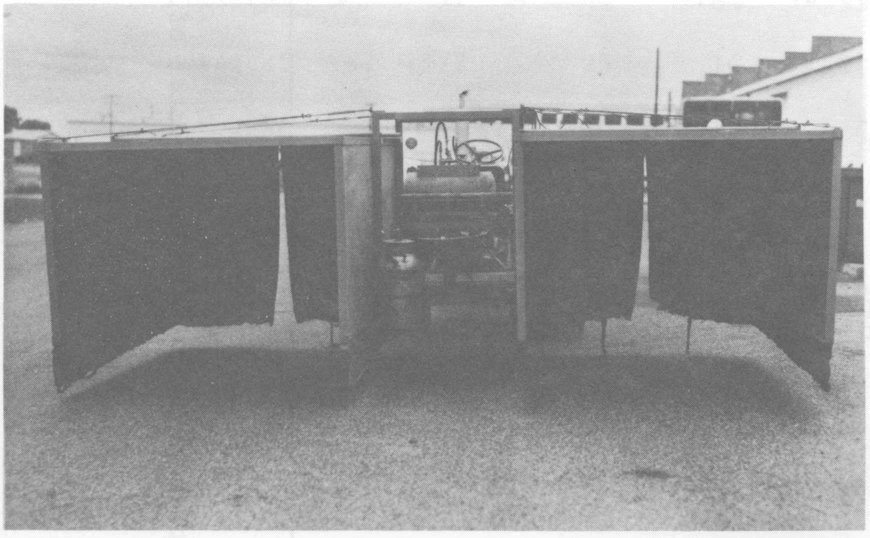

Figure 10. Tractor-mounted sprayer for treating brush up to 6 feet in height.

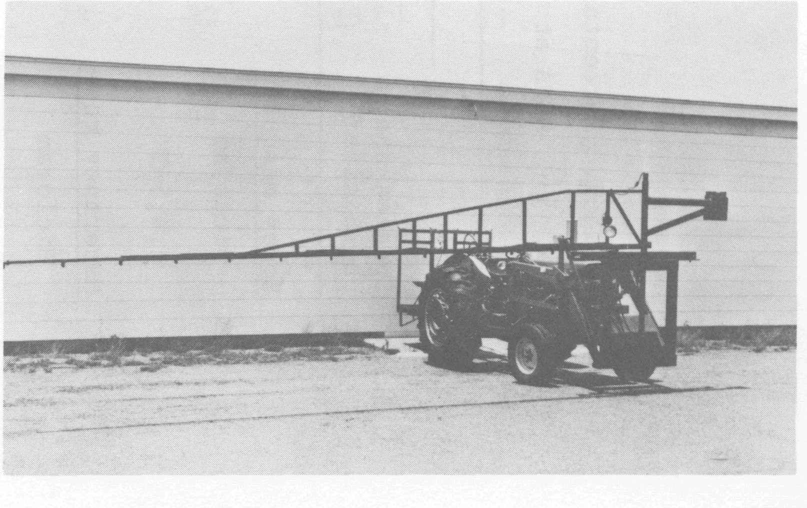

Figure 11. Tractor-mounted sprayer for treating brush up to 15 feet in height.

Table 1. Percentage canopy reduction of four woody plant species treated with picloram and 2,4,5-T or MCPA at three rates and three dates in 1964. 1/

Species and herbicide 2/	Date of treatment								
	13 May			3 June			24 July		
	1/4 lb/A (%)	1 lb/A (%)	4 lb/A (%)	1/4 lb/A (%)	1 lb/A (%)	4 lb/A (%)	1/4 lb/A (%)	1 lb/A (%)	4 lb/A (%)
Honey mesquite									
Picloram	19	75	100	6	33	100	12	38	88
2,4,5-T	50	88	100	19	56	64	6	82	100
Macartney rose									
Picloram	10	100	100	6	75	100	2	95	100
2,4,5-T	5	40	78	0	2	79	0	4	86
Whitebrush									
Picloram	0	19	92	0	12	77	0	0	22
MCPA	0	25	36	0	25	71	12	6	54
Winged elm									
Picloram	0	56	100	0	69	94	0	34	100

1/ Evaluated May 7, 1965.

2/ The potassium salt of picloram, the 2-ethylhexyl ester of 2,4,5-T and the dimethylamine salt of MCPA.

Table 2. Percentage canopy reduction of honey mesquite sprayed with 15 treatments at five dates in 1965. [1]

Herbicide [2]	Rate (lb/A)	Date of treatment: 16 Apr (%)	30 Apr (%)	8 June (%)	30 June (%)	30 July (%)
2,4,5-T	1/2	23	50	38	60	50
2,4,5-T	1	44	36	42	45	58
2,4,5-T	2	20	55	75	75	75
Picloram	1/2	29	48	75	46	48
Picloram	1	33	55	82	78	68
Picloram	2	40	84	95	95	84
Paraquat	1/2	25	16	12	13	18
Paraquat	1	40	17	34	13	3
Paraquat	2	43	28	43	13	27
Paraquat + 2,4,5-T	1/4+1/4	33	12	20	18	20
Paraquat + 2,4,5-T	1/2+1/2	28	16	22	18	18
Paraquat + 2,4,5-T	1+1	45	18	35	35	35
Paraquat + picloram	1/4+1/4	38	12	25	20	18
Paraquat + picloram	1/2+1/2	33	28	32	15	25
Paraquat + picloram	1+1	40	20	48	33	40

1/ Evaluated June 1966.

2/ The potassium salt of picloram, the 2-ethylhexyl ester of 2,4,5-T and the dichloride salt of paraquat.

Table 3. Percentage canopy reduction of honey mesquite treated at two dates with five herbicides at three rates in 1966. 1/

Herbicide	Rate (lb/A)	Date of treatment 29 June (%)	22 July (%)
Picloram, K salt	1/2	98	97
Picloram, K salt	1	100	100
Picloram, K salt	2	98	100
Amine salt of 2,4,5-T	1/2	98	97
Amine salt of 2,4,5-T	1	93	100
Amine salt of 2,4,5-T	2	99	95
Ester of 2,4,5-T	1/2	95	93
Ester of 2,4,5-T	1	99	97
Ester of 2,4,5-T	2	100	100
Picloram + ester of 2,4,5-T	1/4+1/4	99	95
Picloram + ester of 2,4,5-T	1/2+1/2	100	100
Picloram + ester of 2,4,5-T	1+1	100	100
Picloram + amine salt of 2,4,5-T	1/4+1/4	93	97
Picloram + amine salt of 2,4,5-T	1/2+1/2	97	94
Picloram + amine salt of 2,4,5-T	1+1	97	100
Untreated	0	3	5

1/ Evaluated May 8, 1967.

Table 4. Percentage canopy reduction of five species treated with several herbicides in June 1965.[1]

Herbicide	Rate (lb/A)	Species: Honey Mesquite (%)	Live oak (%)	Macartney rose (%)	Winged elm (%)	Greenbrier (%)
Sodium azide	15	0	0	0	0	3
Sodium azide	20	0	0	5	0	3
Sodium azide	25	0	0	5	0	13
Potassium azide	15	0	0	0	0	0
Potassium azide	20	0	0	0	0	0
Potassium azide	25	0	0	0	0	0
Bromacil	2	0	67	0	30	0
Bromacil	8	0	100	5	100	13
Amizine	2	0	0	20	0	33
Amizine	8	0	0	40	0	0
Pyriclor	2	3	0	0	0	2
Pyriclor	8	19	13	5		
Paraquat + amitrole	1+1	0	13	10	0	37
Paraquat + amitrole	4+4	12	20	20	0	10
Picloram	2	97	93	100	100	17
Picloram	8	100	100	100	100	90
Pyriclor + picloram	1-1/3+2/3	23	0	100	20	2
Pyriclor + picloram	5-1/3+2/3	63	100	100	100	3
Picloram + amitrole	1+1	60	7	100	100	43
Picloram + amitrole	4+4	100	100	100	100	100

1/ Evaluated May 1966.

Table 5. Percentage canopy reduction of honey mesquite, live oak, winged elm, Macartney rose, and whitebrush treated with herbicides applied in three volumes of oil-water (1:3 v/v) carrier on June 16, 1965.[1/]

Species and herbicide [2/]	Rate (lb/A)	Gallons per acre	Canopy reduction (%)
Honey mesquite			
2,4,5-T	1/2	4	60
2,4,5-T	1/2	20	95
2,4,5-T	1/2	100	70
Live oak			
2,4,5-T	2	4	44
2,4,5-T	2	20	67
2,4,5-T	2	100	64
Macartney rose			
2,4-D	2	4	27
2,4-D	2	20	46
2,4-D	2	100	34
Whitebrush			
MCPA	1	4	55
MCPA	1	20	60
MCPA	1	100	62
Winged elm			
2,4,5-T	2	4	38
2,4,5-T	2	20	83
2,4,5-T	2	100	59

1/ Evaluated July 1966.

2/ Herbicides included the 2-ethylhexyl ester of 2,4-D and 2,4,5-T and the butoxyethyl ester of MCPA.

Table 6. Percentage canopy reduction of honey mesquite and live oak treated with foliage sprays of picloram or 2,4,5-T with various surfactants [1, 2, 3].

Surfactant	Honey mesquite [4] Picloram (%)	Honey mesquite [4] Ester of 2,4,5-T (%)	Honey mesquite [4] Amine of 2,4,5-T (%)	Live oak [4] Picloram (%)	Live oak [4] Ester of 2,4,5-T (%)	Live oak [4] Amine of 2,4,5-T (%)
Renex 30	80 abcd	55 d	70 abdc	18 abc	5 cd	2 d
Brij 96	98 ab	72 abcd	-	22 ab	0 d	-
HLB 4	-	-	85 abcd	-	-	8 bcd
HLB 10	100 a	62 cd	90 abc	10 bcd	2 d	0 d
HLB 14	88 abc	65 cd	-	10 bcd	2 d	-
HLB 16	90 abc	68 bcd	70 abcd	25 a	5 cd	2 d
Untreated	5 e	5 e	5 e	0 d	0 d	0 d

[1] Evaluated October 14, 1968.

[2] All herbicides and all surfactants applied at rate of 1 pound per acre in water at volume of 20 gallons per acre, June 7 and 16, 1967.

[3] Herbicide formulations were the potassium salt of picloram, 2-ethylhexyl ester and the triethylamine salt of 2,4,5-T.

[4] Means by species followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 7. Percentage canopy reduction of honey mesquite, live oak, and greenbrier from foliage sprays of picloram and 2,4,5-T mixtures applied at 1/2+1/2 pounds per acre with and without surfactants on August 22, 1967. [1/]

Herbicide [2/]	Surfactant [3/]	Honey mesquite [4/] (%)	Live oak [4/] (%)	Greenbrier [4/] (%)
M-3252X [3/]	None	33 bcd	4 de	10 def
M-3252X	Renex 30	73 ab	26 bc	50 ab
M-3252X	Renex 31	70 abc	60 a	48 ab
M-3252X	Renex 36	80 a	76 a	41 abc
M-3252X	Tween 21	77 ab	69 a	61 a
M-3252X	Tween 40	30 cd	4 de	24 bcdef
M-3252X	Tween 80	65 abc	36 b	18 cdef
M-3252X	Tween 81	67 ab	14 cde	30 bcdef
M-3252X	Tween 85	77 ab	58 a	53 ab
M-3252X	Atlox 209	27 cd	16 bcde	18 cdef
M-3252X	ACL 574	70 abc	32 bc	38 abcd
M-3252X	ACL 577	37 abcd	22 bcd	32 bcde
M-3252X	ACL 578	63 abc	30 bc	30 bcdef
Tordon 225	None	50 abcd	28 bc	32 bcde
None	None	10 d	0 e	4 f

1/ Evaluated October 14, 1968.

2/ M-3252X and Tordon 225 each contain 1 pound per gallon each of 2,4,5-T and picloram as the triethylamine salts; however, M-3252X is an experimental formulation without surfactants and Tordon 225 is the commercial formulation.

3/ Surfactant concentration 1% (v/v) of total spray.

4/ Means within a column followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 8. Percent canopy reduction of honey mesquite from foliar sprays of 1/2+1/2 pounds per acre of picloram + 2,4,5-T with and without additives and surfactants, applied June 11, 1968.[1, 2]

Herbicide[3]	Surfactant	Canopy reduction (%)[4]
M-3252X	None	11 e
Tordon 225	None	48 abc
M-3252X	Renex 30	55 abc
M-3252X	Renex 31	60 abc
M-3252X	Renex 36	60 abc
M-3252X	X-77	43 bc
M-3252X	DMSO (1%)	20 de
M-3252X	DMSO (1%) + Renex 30	68 a
M-3252X	DMSO (1%) + Renex 31	63 ab
M-3252X	DMSO (1%) + Renex 36	50 abc
M-3252X	DMSO (1%) + X-77	53 abc
M-3252X	Brij 96	60 abc
M-3252X	DMSO (1%) + Brij 96	55 abc
M-3252X	AL-411A	38 cd
Check	None	0 e

1/ Evaluated June 1969.

2/ All surfactants applied at 1 pound per acre. DMSO was at 1% (v/v).

3/ M-3252X and Tordon 225 each contain 1 pound per gallon each of 2,4,5-T and picloram as the triethylamine salts; however, M-3252X is an experimental formulation without surfactants and Tordon 225 is the commercial formulation.

4/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 9. Percentage canopy reduction of honey mesquite and live oak after application of 2,4,5-T ester in water, diesel oil, or diesel oil-water carriers, sprayed June 9, 1966.[1/]

	Honey mesquite			Live oak		
Carrier	0 lb/A (%)	1/2 lb/A (%)	1 lb/A (%)	0 lb/A (%)	1 lb/A (%)	2 lb/A (%)
Water		94	92		15	35
Diesel oil		98	100		38	42
1:3 diesel oil: water		10	100		10	8
1:9 diesel oil: water		18	99		10	18
1:18 diesel oil: water		55	99		10	30
Diesel oil check[2/]	5			0		
Untreated	2			0		

1/ Evaluated May 3, 1967.

2/ Diesel oil only; no herbicide applied.

Table 10. Percentage canopy reduction of honey mesquite from foliar sprays of picloram or picloram + 2,4,5-T applied June 13, 1968, with various carriers and surfactants. [1, 2]

Herbicide	Carrier	Surfactant	Canopy reduction [6] (%)
Picloram [3]	Diesel oil	-	18 de
Picloram [3]	Naphtha	-	16 ef
Picloram [3]	Mentor 28	-	28 cde
Picloram [3]	S.S. 100	-	45 abcd
Picloram [3]	Diesel oil:water (1:3)	AL-411A	33 bcde
Picloram [3]	Diesel oil:water (1:3)	Renex 30	8 ef
Picloram [3]	Mentor 28	Renex 31	9 ef
Picloram + 2,4,5-T [4]	Water	M-3349	25 de
Picloram + 2,4,5-T [4]	Diesel oil:water (1:3)	M-3349	9 ef
Tordon 225 [5]	Water	X-77	53 abc
Tordon 225 [5]	Diesel oil:water (1:3)	Renex 30	55 ab
Tordon 225 [5]	Water	AL-411 A	50 abcd
Tordon 225 [5]	Diesel oil:water (1:3)	AL-411 A	58 a
Check			0 f

1/ Evaluated June 9, 1969.

2/ All herbicides applied at 1/2 pound per acre. Surfactants were at 0.5% (v/v).

3/ Isooctyl ester.

4/ Isooctyl ester of picloram + propylene glycol isobutyl ether ester of 2,4,5-T (1:1).

5/ Triethylamine salts of picloram + 2,4,5-T (1:1).

6/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 11. Percentage canopy reduction of four woody plant species sprayed with 12 herbicides at 2 pounds per acre on August 6, 1964. 1, 2/

Herbicide & additive	Honey mesquite (%) 3/	Live oak (%) 4/	Macartney rose (%) 3/	Whitebrush (%) 3/
2,4-dimethyltridecylamine	50 d	17	88 a	58 a
2,4-D ethomeen T/15	46 d	33	85 a	-
2,4,5-T ester	88 abc	17	55 ab	6 b
2,4,5-T ester in diesel oil	100 a	58	76 ab	33 a
2,4,5-T ester + 5% glycerol	86 abc	25	70 ab	-
2,4,5-T ester in diesel oil:water (1:3)	94 ab	53	64 ab	-
2,4,5-T ester + 5% propylene glycol	100 a	50	60 ab	-
2,4,5-T ester + dicamba (1:1)	69 c	50	58 ab	-
2,4,5-T ester + 5% C-56	86 abc	53	29 bc	-
2,4,5-T ester + NH_4SCN (20:1)	69 c	11	54 ab	6 b
2,4,5-T triethylamine + 5% hexafluoroacetone	77 bc	31	42 abc	0 b
2,4,5-T triethylamine	92 ab	33	20 c	35 a
Untreated	44 d	0	0 c	0 b

1/ Evaluated May 7, 1965.

2/ The 2,4,5-T applied was the 2-ethylhexyl ester and spray volume was 30 gallons per acre in water unless otherwise indicated.

3/ Means within each column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

4/ Means not statistically different where no letters are presented.

Table 12. Percentage canopy reduction of five species treated with and without ammonium thiocyanate added to oil:water emulsions (1:3 v/v) of 2,4-D, 2,4,5-T, or MCPA on June 16, 1965.[1/]

Herbicide and species	Rate (lb/A)	Canopy reduction (%)
Honey mesquite		
2,4,5-T	1/2	64
2,4,5-T + NH_4SCN	1/2	56
Live oak		
2,4,5-T	2	50
2,4,5-T + NH_4SCN	2	46
Macartney rose		
2,4-D	2	40
2,4-D + NH_4SCN	2	40
Whitebrush		
MCPA	1	82
MCPA + NH_4SCN	1	82
Winged elm		
2,4,5-T	2	55
2,4,5-T + NH_4SCN	2	53

1/ Evaluated May 1966.

Table 13. Percentage canopy reduction of honey mesquite treated with various herbicides and additives on June 17, 1967.[1/]

Herbicide and additive	Rate (lb/A)	Canopy reduction (%)[2/]
Ester of 2,4,5-T	1/2	10 de
Potassium salt of picloram	1/2	32 bcd
Picloram + ester of 2,4,5-T	1/4+1/4	2 e
Picloram + ester of 2,4,5-T + 1% DMSO	1/4+1/4	15 cde
Ester of 2,4,5-T + 1% DMSO	1/2	10 de
Picloram + 1% DMSO	1/2	32 bcd
Triisopropanol amine salts of picloram and 2,4,5-T	1/4+1/4	55 ab
Triisopropanol amine salts of picloram and 2,4,5-T + 1% DMSO	1/4+1/4	12 de
Triisopropanol amine salts of picloram and 2,4-D	1/6+1/3	18 cde
Triisopropanol amine salts of picloram and 2,4-D	1/3+2/3	38 bc
Ester of 2,4,5-T + amitrole + NH_4SCN	1/2+1/10+1/40	5 e
Picloram + amitrole + NH_4SCN	1/2+1/10+1/40	15 cde
Ester of 2,4,5-T + 0.1% G-3300	1/2	65 a
Ester of 2,4,5-T + 1.0% G-3300	1/2	38 bc
Ester of 2,4,5-T + 2.0% G-3300	1/2	32 bcd
Picloram + 0.1% ACL 500	1/2	25 cde
Picloram + 1.0% ACL 500	1/2	15 cde
Picloram + 2.0% ACL 500	1/2	52 ab
Isooctyl ester of picloram	1/2	8 de
Isooctyl ester of picloram + 1% G-3300	1/2	12 de
Untreated	0	5 e

1/ Evaluated October 14, 1968.

2/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 14. Percentage canopy reduction of honey mesquite from foliar sprays of ethephon in combination with picloram, 2,4,5-T, or picloram + 2,4,5-T formulations applied June 18, 1968. [1/]

Herbicide	Rate (lb/A)	Canopy reduction (%)
Ethephon	2	0
Ethephon	4	5
Picloram + 2,4,5-T	1/4	10
Picloram + 2,4,5-T	1/2	30
Picloram + 2,4,5-T + ethephon	1/8+1/8+2	5
Picloram + 2,4,5-T + ethephon	1/8+1/8+4	20
Picloram + 2,4,5-T + ethephon	1/4+1/4+2	20
Picloram + 2,4,5-T + ethephon	1/4+1/4+4	30
Picloram	1/4	20
Picloram	1/2	30
Picloram + ethephon	1/4+2	10
Picloram + ethephon	1/4+4	10
Picloram + ethephon	1/2+2	20
Picloram + ethephon	1/2+4	20
2,4,5-T ester	1/4	50
2,4,5-T ester	1/2	20
2,4,5-T ester + ethephon	1/4+2	10
2,4,5-T ester + ethephon	1/4+4	10
2,4,5-T ester + ethephon	1/2+2	20

[1/] Evaluated May 1969.

Table 15. Percentage canopy reduction of huisache and live oak treated on June 9, 1966 with picloram amine, 2,4,5-T ester or equal ratio combinations of picloram and 2,4,5-T.[1/]

Herbicide	Huisache 2 lb/A (%)	Huisache 4 lb/A (%)	Live oak 2 lb/A (%)	Live oak 4 lb/A (%)
Picloram	100	100	90	99
Ester of 2,4,5-T	84	99	15	15
Amine salt of 2,4,5-T	44	28	20	66
Picloram plus ester of 2,4,5-T	99	100	97	99
Picloram plus amine salt of 2,4,5-T	100	100	82	99

1/ Evaluated April 12, 1967.

Table 16. Percentage canopy reduction of huisache treated with picloram, 2,4,5-T and picloram + 2,4,5-T combinations at three dates in the nursery. 1/

Herbicide	Rate (lb/A)	Date of treatment 2/ 27 Oct 1966 (%)	16 May 1967 (%)	3 Jul 1967 (%)
K salt of picloram 3/	1	95 a	80 abc	85 ab
K salt of picloram 3/	2	100 a	100 a	100 a
Ester of picloram 4/	1	98 a	35 def	70 abcd
Ester of picloram 4/	2	98 a	55 bcdef	95 ab
Amine salt of 2,4,5-T 3/	1	22 d	25 ef	30 e
Amine salt of 2,4,5-T 3/	2	12 d	59 bcde	25 e
Ester of 2,4,5-T 4/	1	0 d	25 ef	38 e
Ester of 2,4,5-T 4/	2	32 cd	28 ef	45 de
K salt of picloram + amine salt of 2,4,5-T 3/	1/2+1/2	20 d	91 ab	90 ab
K salt of picloram + triethylamine salt of 2,4,5-T 3/	1+1	60 bc	72 abcd	68 bcd
Esters of picloram + 2,4,5-T 4/	1/2+1/2	92 ab	15 f	75 abc
Esters of picloram + 2,4,5-T 4/	1+1	100 a	35 def	75 abc
Untreated	-	0	0	0

1/ Evaluated October 15, 1968.

2/ Numbers within a column followed by the same letter do not differ significantly at the 5% level of probability using Duncan's multiple range test.

3/ Surfactant X-77 added at 0.5% (v/v).

4/ Applied in diesel oil at volume of 20 gallons per acre.

Table 17. Percentage canopy reduction of live oak sprayed at three dates in 1965.[1/]

Herbicide	Rate (lb/A)	Date of treatment 16 Apr (%)	8 Jun (%)	8 Sept (%)
2,4,5-T	1	-	-	30
2,4,5-T	2	5	40	38
2,4,5-T	4	20	55	60
Picloram	1	-	-	60
Picloram	2	20	75	88
Picloram	4	65	100	100
Paraquat	1	-	-	40
Paraquat	2	-	30	65
Paraquat	4	-	75	89
Dicamba	1	-	-	20
Dicamba	2	-	-	35
Dicamba	4	-	-	80
Bromacil + paraquat	2+2	30	63	94
Bromacil + paraquat	4+4	45	95	100

1/ Evaluated June 1966.

Table 18. Percentage canopy reduction of live oak and greenbrier by single and multiple foliage treatments.[1, 2]

Initial treatment		Retreatment		Canopy reduction[3]	
Herbicide	Rate (lb/A)	Herbicide	Rate (lb/A)	Live oak (%)	Greenbrier (%)
Picloram	1	None		12 bc	2 bc
Picloram	1	Paraquat	4	12 bc	20 a
Picloram + 2,4,5-T	1/2+1/2	None		0 c	9 abc
Picloram	1/2	2,4,5-T	1/2	22 abc	5 bc
2,4,5-T	1	None		0 c	0 c
2,4,5-T	1	Paraquat	4	18 abc	12 abc
2,4,5-T	1/2	Picloram	1/2	2 bc	2 bc
Paraquat	4	None		15 bc	15 ab
Paraquat	4	Picloram	1	25 ab	20 a
Paraquat	4	2,4,5-T	1	42 a	8 abc
Untreated	-	None		0 c	0 c

1/ Evaluated October 14, 1968.

2/ Initial treatments applied October 24, 1967 and retreatment applied October 26, 1967.

3/ Means within each column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

Table 19. Percentage canopy reduction of live oak from foliage sprays of herbicides applied May 16, 1967.[1/]

Herbicide and additive	Rate (lb/A)	Canopy reduction[2/] (%)
Picloram + 1% DMSO	1	10 d
Picloram + 1% X-77	1	22 bcd
Picloram + 1% DMSO	2	45 ab
Picloram + 1% X-77	2	65 a
Ester of 2,4,5-T + 1% DMSO	1	0 d
Ester of 2,4,5-T + 1% X-77	1	0 d
Ester of 2,4,5-T + 1% DMSO	2	0 d
Ester of 2,4,5-T + 1% X-77	2	0 d
Potassium salt of picloram + ester of 2,4,5-T + 1% DMSO	1/2+1/2	20 bcd
Potassium salt of picloram + ester of 2,4,5-T + 1% DMSO	1+1	12 cd
Dimethyltridecylamine salt of 2,4-D	1	8 d
Dimethyltridecylamine salt of 2,4-D + picloram	1+1	0 d
AP-20	1	0 d
AP-20	2	0 d
AP-20	4	8 d
AP-20 + picloram 33 days later	2+1/2	10 d
AP-20 + picloram 33 days later	2+1	0 d
Picloram + 0.1% ACL 500	1/2	0 d
Picloram + 1.0% ACL 500	1/2	0 d
Picloram + 2.0% ACL 500	1/2	38 bc
Triethylamine salt of 2,4,5-T + 0.1% ACL 500	1	0 d
Triethylamine salt of 2,4,5-T + 1.0% ACL 500	1	0 d
Triethylamine salt of 2,4,5-T + 2.0% ACL 500	1	0 d
Ester of 2,4,5-T + 0.1% G-3300	1	10 d
Ester of 2,4,5-T + 1.0% G-3300	1	5 d
Ester of 2,4,5-T + 2.0% G-3300	1	28 bcd
Ester of 2,4,5-T + 5.0% G-3300	1	0 d
Untreated	0	0 d

1/ Evaluated October 14, 1968.

2/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 20. Percentage canopy reduction of live oak from foliar sprays of picloram + 2,4,5-T at 1+1 pounds per acre with and without various additives and surfactants applied June 12, 1968. 1/

Herbicide	Surfactant 2/	Canopy reduction (%)
M-3252X 3/	-	14
Tordon 225 3/	-	58
M-3252X	Renex 30	35
M-3252X	Renex 31	38
M-3252X	Renex 36	40
M-3252X	Tween 21	48
M-3252X	Tween 80	30
M-3252X	Brij 96	48
M-3252X	HLB 16	38
M-3252X	DMSO (1%) + Renex 31	38
M-3252X	DMSO (1%) + Renex 36	38
M-3252X	DMSO (1%) + Tween 21	58
M-3252X	DMSO (1%) + Tween 80	38
M-3252X	AL-411A	38
M-3252X	X-77	38
Check		18

1/ Evaluated June 9, 1969.

2/ All surfactants applied at 2 pounds per acre. DMSO was at 1% (v/v).

3/ M-3252X and Tordon 225 each contain 1 pound per gallon each of 2,4,5-T and picloram as the triethylamine salts; however, M-3252X is an experimental formulation without surfactants and Tordon 225 is a commercial formulation.

Table 21. Percentage canopy reduction of live oak and greenbrier from foliage sprays of picloram and 2,4,5-T applied August 28, 1967. 1/

	Carrier 2,3/					
	Water			Diesel oil-water 4/		
Herbicide	1 lb/A (%)	2 lb/A (%)	4 lb/A (%)	1 lb/A (%)	2 lb/A (%)	4 lb/A (%)
			Live oak			
Triethylamine salts of picloram and 2,4,5-T	26 ef	60 bcd	78 ab	38 de	68 abc	92 a
Potassium salt of picloram + 2-ethylhexyl ester of 2,4,5-T	6 fg	44 cde	66 abc	18 efg	20 efg	58 bcd
Untreated	2 g					
			Greenbrier			
Triethylamine salts of picloram and 2,4,5-T	12 ef	40 de	79 ab	36 de	51 bcd	98 a
Potassium salt of picloram + 2-ethylhexyl ester of 2,4,5-T	4 f	42 cd	70 abc	2 f	34 de	73 ab
Untreated	0 g					

1/ Evaluated October 14, 1968.

2/ All treatments applied at volume of 20 gallons per acre.

3/ Means in rows 1 and 2 (from left to right) and rows 3 and 4 followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

4/ Renex 30 surfactant added at rate of 0.5% (v/v) of total volume. Diesel oil-water ratio (1:3).

Table 22. Percentage canopy reduction of live oak from foliar sprays of picloram or picloram + 2,4,5-T formulations at 2 and 1+1 pounds per acre, respectively, with various carrier and surfactants, applied June 13, 1968. 1/

Herbicides	Carrier	Surfactant 2/	Canopy reduction 3/ (%)
Picloram, ester 4/	Diesel oil	-	73 a
Picloram, ester 4/	Naphtha	-	65 abc
Picloram, ester 4/	Mentor 28	-	69 ab
Picloram, ester 4/	S.S. 100	-	45 a-e
Picloram, ester 4/	S.S. 100:water (1:3)	Renex 31	3 f
Picloram, ester 4/	Mentor 28:water (1:3)	Renex 30	65 abc
Picloram, ester 4/	Diesel oil:water (1:3)	AL-411A	3 f
Picloram, ester 4/	Naphtha:water (1:3)	Renex 30	28 c-f
Picloram, ester 4/	SX 4029:water (1:3)	Renex 30	9 ef
Picloram, K salt	Water	X-77	38 a-f
Picloram, K salt	Water	AL-411A	45 a-e
Picloram + 2,4,5-T 5/	Diesel oil:water (1:3)	Renex 30	63 abc
Picloram + 2,4,5-T 5/	Mentor 28:water (1:3)	AL-411A	50 a-d
Picloram + 2,4,5-T 5/	Water	AL-411A	40 a-f
Picloram + 2,4,5-T 5/	Diesel oil:water (1:3)	AL-411A 6/	68 ab
Picloram + 2,4,5-T 5/	Water	-	55 abc
Picloram + 2,4,5-T 5/	Water	AL-411A 6/	58 abc
Picloram, K salt + 2,4,5-T ester	Diesel oil:water (1:3)	AL-411A	30 b-f
Picloram, K salt + 2,4,5-T ester	Diesel oil:water (1:3)	Renex 30	33 b-f
Check			2 f

1/ Evaluated June 9, 1969.

2/ Surfactants were applied at 0.5% (v/v) except as indicated.

3/ Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

4/ Isooctyl ester of picloram.

5/ Triethylamine salts of picloram plus 2,4,5-T (1:1).

6/ Surfactants were added at 1.0% (v/v).

Table 23. Percentage canopy reduction of live oak from foliar sprays of picloram, 2,4,5-T and picloram + 2,4,5-T formulations applied June 17, 1968, with various carriers and surfactants. 1, 2/

Herbicide	Carrier	Surfactant	Canopy reduction (%) 3/
Picloram, K salt	Water	Renex 30	9 bcd
2,4,5-T ester 4/	Water	–	25 bcd
Picloram, K salt + 2,4,5-T ester (1:1) 4/	Water	Renex 30	20 bcd
Picloram, K salt + 2,4,5-T ester (1:1) 4/	Diesel oil: water (1:3)	Renex 30	11 bcd
Picloram + 2,4,5-T (1:1) 5/	Water	Renex 30	60 a
Picloram + 2,4,5-T (1:1) 5/	Diesel oil: water (1:3)	Renex 30	35 ab
Picloram + 2,4,5-T (1:1) 5/	Diesel oil: water (1:3)	AL-411A	33 bc
Picloram + 2,4,5-T (1:1) 6/	Water	Oil:water emulsifier 7/	16 bcd
Picloram + 2,4,5-T (1:1) 6/	Diesel oil: water (1:3)	Oil:water emulsifier 7/	0 d
Picloram + 2,4,5-T (1:1) 6/	Mentor 28: water (1:3)	Oil:water emulsifier 7/	3 cd

Table 23 (Cont'd)

Picloram, isooctyl ester + 2,4,5-T ester (1:1) 4/	Diesel oil:water (1:3)	Oil:water emulsifier 7/	1 d
Untreated	-	-	0 d

1/ Evaluated June 1969.

2/ Herbicides applied at a total of 2 pounds per acre; surfactants were applied at 0.5% (v/v).

3/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

4/ Propylene glycol butyl ether esters of 2,4,5-T.

5/ Triethylamine salts of picloram + 2,4,5-T (1:1).

6/ Isooctyl esters of picloram + propylene glycol isobutyl ether esters of 2,4,5-T (1:1).

7/ M-3349 - Dow Chemical U.S.A. oil:water emulsifier.

Table 24. Percentage canopy reduction of live oak plants treated with herbicides + X-77 or DMSO at four concentrations on June 22, 1966.[1/]

Herbicide and surfactant	Rate (lb/A)	Additive concentration (%)			
		0	0.1	1.0	10.0
Picloram + X-77	1	66	82	94	100
Picloram + DMSO	1	82	57	82	94
Picloram + X-77	2	95	71	80	99
Picloram + DMSO	2	94	90	64	90
2,4,5-T + X-77	1	28	8	5	10
2,4,5-T + DMSO	1	9	6	10	10
2,4,5-T + X-77	2	20	20	38	18
2,4,5-T + DMSO	2	20	40	52	12
Paraquat + X-77	1	70	75	22	89
Paraquat + DMSO	1	76	32	35	60
Paraquat + X-77	2	69	72	70	83
Paraquat + DMSO	2	56	76	62	72
Untreated	0	4			

1/ Evaluated May 19, 1967.

Table 25. Percentage canopy reduction of Macartney rose treated at three dates in May 1966 with three rates of three herbicides. 1/

Herbicide	Rate (lb/A)	Date of treatment 9 May (%)	19 May (%)	31 May (%)
Picloram	1/2	100	77	35
Picloram	1	100	85	82
Picloram	2	100	100	78
2,4-D	1/2	42	8	27
2,4-D	1	48	18	25
2,4-D	2	96	80	50
Picloram + 2,4-D	1/8+3/8	23	25	15
Picloram + 2,4-D	1/4+3/4	100	91	32
Picloram + 2,4-D	1/2+1-1/2	100	98	85
Check	-	7	8	7

1/ Evaluated May 19, 1967.

Table 26. Percentage canopy reduction of Macartney rose treated at three dates in 1967.[1/]

		Date of treatment [2/]		
Herbicide	Rate (lb/A)	15 May (%)	19 June (%)	18 July (%)
Potassium salt of picloram	1/2	98 a	75 ab	61 b
Potassium salt of picloram	1	100 a	54 abcd	99 a
Potassium salt of picloram	2	100 a	100 a	100 a
Amine salt of 2,4-D	1/2	2 c	30 bcd	30 c
Amine salt of 2,4-D	1	5 c	45 bcd	29 c
Amine salt of 2,4-D	2	58 b	75 ab	35 c
Potassium salt of picloram + amine salt of 2,4-D	1/8+3/8	28 c	18 cd	59 b
Potassium salt of picloram + amine salt of 2,4-D	1/4+3/4	100 a	71 abc	72 b
Potassium salt of picloram + amine salt of 2,4-D	1/2+1-1/2	75 ab	100 a	98 a
Check	-	0 c	0 d	2 d

1/ Evaluated May 29, 1968.

2/ Means in the same column followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 27. Percentage canopy reduction of Macartney rose with herbicides and additives applied June 17, 1967. 1/

Herbicide	Additive and concentration		Rate of herbicide (lb/A) 2/ 1/2 (%)	1 (%)	2 (%)	4 (%)
Picloram	DMSO	1%		56 c-h	99 a	
Picloram	X-77	1%		96 ab	100 a	
Ester of 2,4-D	DMSO	1%		46 d-j	69 a-e	
Ester of 2,4-D	X-77	1%		44 e-k	61 a-g	
Picloram + ester of 2,4-D (1:1)	DMSO	1%		98 a	99 a	
Dimethyltridecylamine salt of 2,4-D		0		58 a-h	94 abc	
Dimethyltridecylamine salt of 2,4-D + picloram		0			65 a-f	
AP-20		0		15 i-l	2 l	26 f-l
AP-20 + picloram at 1/2 lb/A		0			92 abc	
AP-20 + picloram at 1 lb/A		0			92 abc	
Picloram	ACL 500	0.1%	55 c-i			
Picloram	ACL 500	1.0%	32 e-l			
Picloram	ACL 500	2.0%	84 a-d			
Dimethylamine salt of 2,4-D	ACL 500	0.1%		22 g-l		
Dimethylamine salt of 2,4-D	ACL 500	1.0%		20 h-l		
Dimethylamine salt of 2,4-D	ACL 500	2.0%		29 e-l		
Ester of 2,4-D	G-3300	0.1%		34 e-l		
Ester of 2,4-D	G-3300	1.0%		22 g-l		
Ester of 2,4-D	G-3300	2.0%		38 e-l		
Ester of 2,4-D	G-3300	5.0%		8 jkl		
Ester of 2,4-D + TD-480 (1:1)	X-77	1.0%			25 f-l	
Picloram + TD-480	X-77	1.0%			69 a-e	

1/ Evaluated June 1968.

2/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 28. Percentage canopy reduction of Macartney rose treated with foliage sprays of picloram or 2,4-D and surfactants on July 3, 1967.[1, 2, 3/]

		Herbicide		
Surfactant	No herbicide	Picloram (%)	Ester of 2,4-D (%)	Amine of 2,4-D (%)
Renex 30	10 b		30 b	25 b
Renex 36	20 b	100 a		
Myrj 45		100 a		
Brij 96		100 a	20 b	
HLB 4	0 b			21 b
HLB 10	0 b	100 a	6 b	25 b
HLB 14		100 a	15 b	
HLB 16	10 b		2 b	15 b
Untreated	5 b			

1/ Evaluated May 29, 1968.

2/ All herbicides and all surfactants applied at rate of 1 pound per acre in water at volume of 20 gallons per acre.

3/ Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 29. Percentage canopy reduction of Macartney rose from foliage sprays of picloram + 2,4-D applied on August 28 and 29, 1967.[1, 2, 3/]

	Carrier					
	Water			Diesel oil-water		
Herbicide	1 lb/A (%)	2 lb/A (%)	4 lb/A (%)	1 lb/A (%)	2 lb/A (%)	4 lb/A (%)
Triethylamine salt of picloram + 2,4-D	94	100	100	100	100	100
Potassium salt of picloram + 2-ethylhexyl ester of 2,4-D	100	100	100	98	100	100

1/ Evaluated May 29, 1968.

2/ Renex 30 surfactant added at rate of 0.5% (v/v) of total volume.

3/ Means of herbicide-treated plots were not significantly different at the 5% level. The untreated mean at 2%, however, was significantly different from all herbicide treatments.

Table 30. Percentage canopy reduction of Macartney rose plants treated with herbicide + X-77 or DMSO at four concentrations on June 28, 1966.[1/]

Herbicide and surfactant	Rate (lb/A)	Surfactant concentration 0 (%)	0.1 (%)	1.0 (%)	10.0 (%)
Picloram	1/4	10	20	18	25
Picloram + DMSO	1/4	-	18	15	5
Picloram + X-77	1/2	38	30	60	74
Picloram + DMSO	1/2	-	30	44	44
2,4-D + X-77	1	12	10	12	8
2,4-D + DMSO	1	-	12	10	12
2,4-D + X-77	2	48	40	55	38
2,4-D + DMSO	2	-	22	25	28
Paraquat + X-77	1	20	8	10	10
Paraquat + DMSO	1	-	12	8	12
Paraquat + X-77	2	15	12	25	15
Paraquat + DMSO	2	-	20	18	10
Untreated	0	4			

1/ Evaluated May 19, 1967.

Table 31. Percentage canopy reduction of Macartney rose plants treated with herbicides + X-77 or DMSO at four concentrations on August 5, 1966.[1/]

Herbicide and surfactant	Rate (lb/A)	Surfactant concentration 0 (%)	0.1 (%)	1.0 (%)	10.0 (%)
Picloram + X-77	1/4	25	52	50	69
Picloram + DMSO	1/4	-	25	20	37
Picloram + X-77	1/2	70	82	87	94
Picloram + DMSO	1/2	-	76	50	48
2,4-D + X-77	1	40	5	10	10
2,4-D + DMSO	1	-	10	8	10
2,4-D + X-77	2	18	34	20	22
2,4-D + DMSO	2	-	15	15	30
Untreated	0	6			

1/ Evaluated May 25, 1967.

Table 32. Percentage canopy reduction and percent dead whitebrush plants treated on three dates in April 1965 with 1 pound per acre of MCPA or picloram.[1/]

	Herbicide			
	MCPA		Picloram	
Date sprayed	Canopy reduction (%)	Dead plants (%)	Canopy reduction (%)	Dead plants (%)
April 9	83	0	100	100
April 20	88	12	100	100
April 29	90	0	99	90

1/ Evaluated October 20, 1965.

Table 33. Percentage canopy reduction and dead whitebrush plants treated with picloram or picloram + amitrole-T in 1967 and 1968.[1/]

		Date of treatment			
		October 12, 1967		August 29, 1968 2/	
Herbicide	Rate (lb/A)	Canopy reduction (%)	Dead plants (%)	Canopy reduction (%)	Dead plants (%)
Picloram	1/2	58	21	53 a	24 a
Picloram + amitrole-T	1/2+1/2	76	57	71 a	55 a
Picloram + amitrole-T	1/2+1	73	30	74 a	42 a
Untreated		22	0	25 b	0 b

1/ Evaluated August 29, 1968.

2/ Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 34. Percentage canopy reduction and whitebrush plants killed by sprays applied May 1, 1967. 1/

Herbicide and surfactant	Rate (lb/A)	Canopy reduction 2/ (%)	Dead plants 2/ (%)
Picloram	1/2	63 bcde	26 ab
Picloram + 1% DMSO	1/2	62 bcde	33 ab
Picloram + 2,4,5-T (amine salts)	1/4+1/4	61 cde	29 ab
Picloram + 2,4,5-T (amine salts)	1/2+1/2	85 abcd	45 ab
Picloram + 2,4,5-T + silvex	1/2+1/4+1/4	87 abc	63 a
Picloram + 2,4-D (amine salts)	1/6+1/3	83 abcd	36 ab
Picloram + 2,4-D (amine salts)	1/3+2/3	91 ab	50 a
Picloram + 2,4-D (amine salts)	1/2+1	89 abc	60 a
Picloram + 0.14% Span 20 + 0.86% Tween 80	1/2	56 de	18 ab
Picloram + 1% Renex 30	1/2	46 c	19 ab
Picloram ester	1/2	94 a	63 a
Untreated	-	12 f	0 b

1/ Evaluated August 28, 1968.

2/ Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 35. Percentage canopy reduction and whitebrush plants killed by sprays applied May 28, 1969.[1/]

Herbicide[2/]	Rate (lb/A)	Canopy reduction (%)	Dead plants (%)
Picloram	1	94	52
Picloram + 2,4,5-T (Tordon 225)	1/2+1/2	69	27
Picloram + 2,4-D (Tordon 212)	1/3+2/3	91	44
2,4-D	1	90	23
2,4-D + DSMA (D-345)	1+2-1/2	73	0
2,4-D + DSMA (Transvert)	1+2-1/2	31	0
Untreated	-	15	0

1/ Evaluated September 12, 1969.

2/ X-77 was added at 0.125% v/v.

Table 36. Percentage canopy reduction and whitebrush plants killed by 1 pound per acre of nine phenoxy herbicides, picloram, pyriclor and karbutilate, sprayed September 22, 1966. 1/

Herbicide 2/	Canopy reduction 3/ (%)	Dead plants 3/ (%)
MCPA	99 a	95 ab
Mecoprop	87 bc	55 c
MCPB	94 abc	70 bc
2,4-D	94 ab	70 bc
Dichlorprop	25 e	0 d
2,4-DB	84 c	45 c
2,4,5-T	48 d	0 d
Silvex	43 d	0 d
2,4,5-TB	26 e	5 d
Picloram, K salt	100 a	100 a
Pyriclor	10 f	0 d
Karbutilate	12 f	0 d
Untreated	10 f	0 d

1/ Evaluated October 25, 1967.

2/ Herbicides included the dimethylamine salt of MCPA; butoxy ethanol ester of mecoprop, MCPB, 2,4-D, 2,4-DB, dichlorprop and 2,4,5-TB; propylene glycol butyl ether esters of 2,4,5-T and silvex; potassium salts of picloram and pyriclor; and 80% wettable powder of karbutilate.

3/ Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 37. Percentage canopy reduction and dead plants of whitebrush from sprays of picloram, 2,4-D and 2,4,5-T, and mixtures of picloram with X-77, DMSO and/or diesel oil on June 13, 1968. 1/

Treatment 2/	Total chemical rate (lb/A) 3/ 0.5 (%)	1 (%)	1.5 (%)	2 (%)	3 (%)	4 (%)	6 (%)
Picloram	36 ab 10						
Picloram + X-77	51 abc 30	70 cdef 60		100 f 100			
Picloram ester (isooctyl)	21 a 0						
Picloram + 2,4,5-T amines 1:1 (Tordon 225) + X-77		39 ab 15		82 def 52		95 ef 75	
Picloram + 2,4,5-T ester (1:1)		73 cdef 30					
Picloram + 2,4-D 1:2 amines + X-77 (Tordon 212)			59 bcd 15		94 ef 75		99 f 95
Picloram + 1% DMSO + X-77	38 ab 10						
Picloram + 10% DMSO + X-77	43 abc 20						
Picloram + 20% DMSO + X-77	35 ab 20						
Picloram + 1/10 v/v diesel oil + X-77	66 bcde 45						

1/ Evaluated May 26, 1969.

2/ Surfactant X-77 was added at 0.125% where indicated. Untreated plants were 0/11% dead/defoliated at rating.

3/ Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test for percentage canopy reduction of whitebrush.

Table 38. Percentage canopy reduction and dead whitebrush from sprays of MCPA and picloram with and without X-77, DMSO and diesel oil + X-77 treated on September 23, 1966. 1/

Herbicide	Rate (lb/A)	Canopy reduction 2/ (%)	Dead plants 2/ (%)
MCPA	1	98 a	90 ab
MCPA + 0.1% X-77	1	98 a	80 ab
MCPA + 0.5% X-77	1	99 a	95 a
MCPA + 1.5% X-77	1	93 a	60 abc
MCPA + 0.1% DMSO	1	95 a	80 ab
MCPA + 0.5% DMSO	1	94 a	75 ab
MCPA + 1.5% DMSO	1	99 a	95 a
MCPA + 1/8 v/v diesel oil + 0.5% X-77	1	99 a	95 a
Picloram	0.5	93 a	70 abc
Picloram + 0.1% X-77	0.5	54 b	30 cd
Picloram + 0.5% X-77	0.5	81 a	50 bc
Picloram + 1.5% X-77	0.5	91 a	60 abc
Picloram + 0.1% DMSO	0.5	54 b	15 d
Picloram + 0.5% DMSO	0.5	60 b	30 cd
Picloram + 1.5% DMSO	0.5	92 a	65 abc
Picloram + 1/8 v/v diesel oil + 0.5% X-77	0.5	87 a	70 abc
Untreated	0	10 c	0 d

1/ Evaluated October 25, 1967.

2/ Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 39. Percentage canopy reduction of winged elm treated at three dates with three herbicides in 1965.[1/]

Herbicide	Rate (lb/A)	Date of treatment 25 Apr (%)	8 June (%)	30 June (%)
2,4,5-T	1	10	12	5
2,4,5-T	2	15	45	0
2,4,5-T	4	65	75	15
Picloram	1	100	70	40
Picloram	2	100	100	80
Paraquat	1	20	10	0
Paraquat	2	10	12	0
Paraquat	4	10	35	0

1/ Evaluated May 1966.

Table 40. Percentage canopy reduction of winged elm treated at two dates with three herbicides and three rates in 1966.[1/]

Herbicide	Rate (lb/A)	Canopy reduction 9 May (%)	Canopy reduction 31 May (%)
Picloram	1	66	41
Picloram	2	78	68
Picloram	3	96	89
Ester of 2,4,5-T	1	15	8
Ester of 2,4,5-T	2	15	25
Ester of 2,4,5-T	3	30	28
Picloram + 2,4,5-T	1/2+1/2	15	30
Picloram + 2,4,5-T	1+1	58	55
Picloram + 2,4,5-T	1-1/2+1-1/2	80	60
Untreated	-	8	1

1/ Evaluated May 31, 1967.

Table 41. Percentage canopy reduction of winged elm sprayed with five herbicides on May 13, 1964.[1/]

Herbicide	Rate (lb/A)	Canopy reduction (%)
Picloram	1	69
2,4,5-T ester	2	12
Paraquat	4	25
Dicamba	4	38
Bromacil	5	88
Untreated	0	6

1/ Evaluated May 7, 1965.

Table 42. Percentage canopy reduction of greenbrier treated at four dates with five herbicides at three rates in April and June 1965.[1/]

		Date of treatment			
Herbicide	Rate (lb/A)	16 Apr (%)	30 Apr (%)	8 Jun (%)	30 Jun (%)
2,4,5-T	2	0	0	7	5
2,4,5-T	4	0	10	0	8
2,4,5-T	8	8	30	8	28
Picloram	2	25	0	0	5
Picloram	4	5	0	3	8
Picloram	8	3	25	10	61
Paraquat	2	0	25	25	8
Paraquat	4	0	3	5	12
Paraquat	8	0	5	3	18
Bromacil	2	0	0	0	2
Bromacil	4	0	0	0	0
Bromacil	8	0	0	3	7
Dicamba	2	0	0	0	0
Dicamba	4	25	0	25	8
Dicamba	8	0	0	5	10

1/ Evaluated May 1966.

Table 43. Percentage canopy reduction of greenbrier treated with 2,4,5-T or a mixture of picloram + amitrole at five dates in 1967.[1/]

Date of treatment	Herbicide [2, 3/] 2,4,5-T (%)	Picloram + amitrole (%)
16 May	46 b	6 c
19 June	0 c	10 c
3 July	52 ab	14 c
28 August	52 ab	25 bc
24 October	55 ab	77 a
Untreated	3 c	8 c

[1/] Evaluated October 14, 1968.

[2/] The 2-ethylhexyl ester of 2,4,5-T applied at 4 lb/A and a 1:1 mixture of potassium salt of picloram + amitrole at 2+2 lb/A.

[3/] Means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.

Table 44. Percentage canopy reduction of loblolly pine sprayed at three dates in 1965.[1/]

Herbicide	Rate (lb/A)	Date of treatment 16 Apr (%)	8 Jun (%)	3 Sept (%)
2,4,5-T	1	15	33	0
2,4,5-T	2	40	20	15
2,4,5-T	4	50	65	20
Picloram	1	20	45	10
Picloram	2	55	95	50
Picloram	4	98	100	85
Paraquat	1	80	100	25
Paraquat	2	63	100	55
Paraquat	4	67	100	90
Dicamba	1	10	85	0
Dicamba	2	35	85	25
Dicamba	4	55	100	65

1/ Evaluated May 1966.

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