Response of Velvet Mesquite in Southern Arizona to Airplane Spraying with 2,4,5-T

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An increasing amount of attention has been given to the use of chemicals for control of undesirable plants. Recent reports have noted the possibility of chemical control of mesquite (Prosopis spp.) now occurring to some degree on about 70 million acres of southwestern rangeland (Glendening, 1952; Fisher and Meadors, 1953). Application of 2,4,5-T by airplane has been recommended.

Velvet mesquite (P. julifora var. velutina) infests about 9 million acres of the rangelands of southern Arizona to some extent (Fig. 1). In the last half century velvet mesquite has increased and moved from its natural habitat along the drainage ways out onto the grass covered flats and ridges (Brown, 1950; Culley, 1949; Parker and Martin 1953). As mesquite spreads into the grassed areas, perennial grass forage production decreases and thereby beef production is lowered (Parker and Martin, 1953). Maintaining the productivity of southern Arizona rangelands is dependent to a large extent on finding a cheap, effective method of controlling velvet mesquite.

This paper presents data from tests to determine the response of the velvet mesquite of southern Arizona to airplane spraying with two forms of 2,4,5-T, in each of four carriers, at three volumes, and on three sites.

Methods
The study consists of two parts: (a) extensive tests of ester and amine forms of 2,4,5-T, carriers and volumes of spray solutions on the Santa Rita Experimental Range (located about 35 miles south of Tucson, Arizona), and (b) less extensive tests of ester and amine forms of 2,4,5-T and volume of application at three sites in Arizona.

The study area on the Santa Rita Experimental Range was located on coarse sandy loam soils of the Tumacacori and White House series. The plots are laid out on a gentle outwash slope at about 4,000 feet elevation and with an average annual rainfall of about 15 inches. Velvet mesquite of mixed age covered the area at a density of 200 to 300 plants per acre. Treatments were designed to compare all possible combinations of: (1) an amine salt and a low-volatile ester of 2,4,5-T at 3/4 pound acid equivalent per acre; (2) application of 5, 10 and 20 gallons of solution per acre; (3) 1:3 and 1:7 oil-water emulsions as carriers; and (4) diesel oil and a nonphytotoxic oil (Helix 20) as the oil phase of the carrier.

The second phase of this study was a comparison of mesquite control obtained with ester and amine forms of 2,4,5-T when applied at rates of 5, 10 and 20 gallons per acre on three sites: the Santa Rita Experimental Range, Ranch A near Patagonia, and Ranch B near Nogales, Arizona. The Santa Rita plots were at a 4,000-foot elevation receiving about 15 inches of annual rainfall. The Ranch A plots were on tight loam soils at about 4,000 feet elevation receiving an
annual rainfall averaging slightly over 16 inches. Ranch B plots were on coarse sandy loam soils at about 4,000 feet elevation receiving an average annual rainfall of just under 17 inches.

Spraying was conducted at the growth stage at which velvet mesquite had been found most susceptible to 2,4,5-T (Roach and Glendenning, 1953). This optimum stage is characterized by fully-developed succulent leaves, blooming nearly complete on most flower clusters, and development of some pods up to one inch in length. Treatments were made on 5-acre plots separated by 100-foot isolation strips. Application was by a Stearman plane equipped with pressure-tip orifices in the boom set for 42-foot flight swaths. Flying was just above the tree tops.

The comparisons of the amine and ester formulations stemmed from results of earlier field and laboratory tests with forms of 2,4,5-T at the Santa Rita Research Center (Rocky Mountain Forest & Range Expt. Sta. Ann. Rept., 1953). Amine salts were found to translocate more readily than esters in the laboratory tests at the Santa Rita Experimental Range. In field tests the esters had usually given higher percentage plant kills than the amines, but the highest percentage kill from any single field treatment prior to 1951 was with an amine. In 1951 tests it was decided to study the effect of volume at 5, 10 and 20 gallons per acre, ignoring the added cost of applying the higher rates. Other work indicated the higher volumes should increase the effectiveness of the herbicide. Cost of treatment prior to 1951 was with an amine. The ester of 2,4,5-T gave a higher percentage top kill and actual plant kill than did the amine (Table 1). The mean percentage plant kill of 35.2 obtained on the ester plots was 10 percent higher than from the amine; and the mean top kill was 6.4 percent higher. An analysis of variance showed these differences to be significant at the 1 percent level.

The mean percentage plant kill of 25.2 from the 5 gallons of spray solution per acre was 6.8 and 8.8 percent lower than from the 10 and 20 gallon per acre rates, respectively. These differences were significant at the 5 percent level. The difference between plant kills from the 10- and 20-gallon rates and differences in top kill between all three volumes were small and did not approach statistical significance.

The comparison of diesel oil versus a nontoxic oil in the carrier showed little difference either in plant kill or top kill. The slightly higher percentages of both plant kill and top kill favored the use of diesel oil.

The 1:3 ratio of oil and water showed an average kill of 30.7 percent compared to 29.7 percent for the 1:7 ratio. The top kills were 73.0 percent and 71.2 percent for the 1:3 and 1:7 ratios, respectively. There was no significant difference in actual plant kill. The difference in top kill is highly significant, but not important from a practical standpoint.

### Table 1. Percent plant kill and topkill of velvet mesquite from aerial spray applications at Santa Rita Experimental Range in May, 1951 of ester and amine forms of 2,4,5-T at ¼ lb/A as related to volume of application and nature of oil in emulsion carrier. Observations made August, 1953.

<table>
<thead>
<tr>
<th>Volume and type of oil in carrier</th>
<th>Ester</th>
<th>Amine</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:3 O/W K* TK</td>
<td>1:7 O/W K TK</td>
<td>1:3 O/W K TK</td>
</tr>
<tr>
<td>5 gal/acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>22.70 28.71</td>
<td>22.69 28.74</td>
<td>24.5 71.8</td>
</tr>
<tr>
<td>Nontoxic</td>
<td>24.68 28.68</td>
<td>24.68 28.69</td>
<td>26.0 71.5</td>
</tr>
<tr>
<td>10 gal/acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>44.79 40.78</td>
<td>30.67 22.71</td>
<td>34.0 73.8</td>
</tr>
<tr>
<td>Nontoxic</td>
<td>40.81 40.69</td>
<td>18.69 22.69</td>
<td>33.0 72.0</td>
</tr>
<tr>
<td>20 gal/acre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>44.81 52.83</td>
<td>32.68 20.61</td>
<td>37.0 73.2</td>
</tr>
<tr>
<td>Nontoxic</td>
<td>30.83 30.70</td>
<td>38.76 20.69</td>
<td>29.5 74.5</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>36.7 76.7</td>
<td>40.0 78.3</td>
<td>28.6 68.0</td>
</tr>
<tr>
<td>Nontoxic</td>
<td>31.3 77.3</td>
<td>32.7 69.0</td>
<td>26.6 70.0</td>
</tr>
<tr>
<td>Total Avg.**</td>
<td>30.7 73.0</td>
<td>29.7 71.2</td>
<td>35.2 75.3</td>
</tr>
</tbody>
</table>

- **K**—percent of trees with tops dead and no sprouting; **TK**—percent of crown rendered non-functional, based on individual trees.
- Least square difference in plant kill at 0.01 level for ester vs. amine was 2.74; at 0.05 level for volume, 3.73; ratio and oil in carrier, no significant difference. In percentage topkill at 0.01 level for ester vs. amine, the L.S.D. was 2.96; for ratio, 2.96; and for volume and oil in carrier, no significant difference.

**Results**

**Santa Rita Experimental Range Plots**

The ester of 2,4,5-T gave a higher percentage top kill and actual plant kill than did the amine (Table 1). The mean percentage plant kill of 35.2 obtained on the ester plots was 10 percent higher than from the amine; and the mean top kill was 6.4 percent higher. An analysis of variance showed these differences to be significant at the 1 percent level.

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**Site Differences**

An analysis of variance of the data shows that some factors associated with site seem to affect
plant kill and top kill as much as either formulations or volumes (Table 2). The average percentages of plant kill and top kill for all three sites showed the ester form to be more effective than the amine salt. These differences were highly significant as shown by values for Least Square Differences.

For all three sites percentage of plant kill and top kill from the 10- and 20-gallons-per-acre rates were higher than from 5 gallons per acre. The average of 7.9 percent difference in plant kill between the 5- and 10-gallon rates was significant but the 4.9 percent difference between the 5- and 20-gallon rates was not significant. However, in terms of percentage of top kill the differences in the 5- and 10-gallon rates were highly significant, indicating that volume is highly important in respect to top kill.

The more effective results with the ester form in contrast to the amine concur with results of a great number of tests. However, an important point was the effect of site on form of 2,4,5-T (Table 2). At the Santa Rita Experimental Range the ester form resulted in a much better plant kill and a slightly better top kill than the amine. At Ranch A the ester produced a better plant kill from 5 gallons of spray per acre but the amine was equally effective in plant kill and top kill in applications at 10- and 20-gallons per acre. At Ranch B plant kill and top kill of mesquite were variable but averaged practically the same with either form of 2,4,5-T.

**Discussion**

The 10 gallon-per-acre rate was the most effective volume with either the ester or amine in terms of plant kill and top kill at the three sites, but the relationship for volumes varied between form at the three sites. Though the 10-gallon rate was more effective than the 5-gallon rate, careful consideration should be given to the added cost of using 10 gallons. On the low-value rangelands of southern Arizona and with the relatively low percentage plant kills obtained, even from the 10-gallon rate, costs must be kept very low to justify the use of airplane sprays in place of slower but surer ground application methods.

The results of the diesel oil/nontoxic oil comparison favor the continued use of diesel oil in the oil phase because of its much lower cost. Cost also favors the use of a 1:7 oil-water emulsion over the 1:3 emulsion.

The difference in percentage plant kill due to effect of site is extremely important. It might be evidence of genetic differences in the plants, variations in soils, or climatic differences with accompanying differences in plant development at spray time. Ranches A and B both receive slightly more average annual rainfall than does the Santa Rita. It has generally been the feeling of researchers in this area that added moisture would increase the effectiveness of 2,4,5-T. This one study indicates that added tests are needed at several additional sites before recommendations for widespread airplane spraying of velvet mesquite with 2,4,5-T can be made.

**Summary**

Tests were made of the effects of ester and amine forms of 2,4,5-T volume of spray application, ratio of oil-water in the carrier, diesel oil and nontoxic oil, and site on spraying of velvet mesquite by airplane at the Santa Rita Experimental Range and two cooperating ranches in southern Arizona in 1951.

The percentage plant kills ranged from 5 to 65 for different treatments at different sites, and averaged 23.6 percent for all tests. Percentage top kills varied from 58 to 91 and averaged 75.8 percent for all treatment on all sites.

Site differences caused much variation in results. The ester of 2,4,5-T was much superior to the amine at one site and slightly superior at a second site, but the two forms were almost equally effective at a third site. The most effective volume varied with site and with formulation, but 10 gallons per acre gave the best average results. At the Santa Rita Experimental Range comparisons of oil-water ratio (1:3 vs. 1:7) and oil (diesel oil vs. nontoxic oil) showed the 1:3 ratio was only slightly superior and diesel oil was as good or better than the nontoxic oil.

**LITERATURE CITED**


Crafts, A. S. 1953. Herbicides, their
In recent years the concepts of range condition and trend have received so much attention that most of you are thoroughly familiar with the general principles of judging the range. Many of you are acquainted with the different schools of thought and with different methods that have been developed by individual workers or groups of workers.

Most of us will agree that range evaluation should have an ecological basis. Of course, with this approach, we immediately come into contact with principles and processes, of which succession is one of the most important. And succession leads us to a consideration of the “top”, the optimum, or the climax condition. Right here we have disagreement.

Even the ecologists do not agree on what is the climax (Whittaker, 1953). And not all range men are convinced that climax should be synonymous with “top” range condition. Hence we have a perennial question: Should we wait and hope that the ecologists will get together, or should we formulate our own definitions of top condition for the various range types?

If we formulate our own definitions of top condition, where shall we draw the line on broad plant communities or range types? Whittaker (1953) has stated that “...climax vegetation is a pattern of populations corresponding to the pattern of environmental gradients, and more or less diverse according to diversity of environments and kinds of populations in the pattern.” This means essentially that every site has its own potential. It means, for example, in the ponderosa pine type of the Rocky Mountains, that dry rocky ridge tops, wet meadows, shrub covered slopes, and bunchgrass communities are different populations in the overall pattern of the ponderosa pine-Douglas fir climax of the region. These populations are present because of diversities in the broad climax.

How shall we develop condition and trend standards for these distinct populations? Shall we develop standards for the type as a whole? Or shall we follow the rule that each meadow, ridge top, or other community depicts a site that is capable of developing its own topographic, physiographic, edaphic or biotic climax? A study of the many methods range men have developed shows that one or the other of these practices has been followed, depending upon background, training, facilities for work, and extent of territory under supervision.

What does this lack of uniformity in approach mean? It indicates at least that joint discussion by those who advocate or use different methods might point the way to more consistent study in the future.

The pattern of factors used for measuring and recording range