Factors Affecting Mesquite Control with Tordon 225 Mixture

RONALD E. SOSEBEE, B. E. DAHL, AND JOHN P. GOEN

Highlight: *The influence of various site characteristics was studied for Tordon 225 Mixture effectiveness in honey mesquite control in the Rolling Plains of Texas. Tordon 225 Mixture was commercially applied in 1970 at 0.5 lb a.e./acre under an experimental label for Texas. Generally, soil temperature (18-inch depth) above 75°F, relatively low soil water content (0 to 6-inch depth), and tree height (less than 8 ft) were most influential in the root mortalities obtained in this study.*

Chemical control of honey mesquite (*Prosopis glandulosa* var. *glandulosa*) often results in erratic success. It has long been established, however, that mesquite kills from herbicides are greatest on upland and sandy sites and kills are consistently less on bottomland or deep hardland sites (Fisher et al., 1959). Recently Dahl et al. (1971) and B. E. Dahl, Ronald E. Sosebee, and John P. Goen (unpublished data) found soil temperature between the 12-and 24-inch depth to be the most important environmental factor influencing mesquite mortality from 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T). Hence, the objective of this study was to determine the influence of various environmental conditions and stage of growth on honey mesquite mortality from Tordon 225 Mixture[1] herbicide (picloram plus 2,4,5-T).

Procedures

In the summer of 1970, 15 sites (locations) were selected on four ranches in the Rolling Plains from Kalgary to Water Valley, Texas. On each site, 25 trees were permanently marked for individual study. The sites varied in exposure, topography, soil type and densities of mesquite. At the time of herbicide application, the following environmental parameters were measured: soil temperature, soil water content, relative humidity, air temperature, depth to $CaCO_3$ effervescence with 10% HCl, and the time of day. Height, basal diameter, stage of phenological development, and abundance of flowers were noted for each tree at the time of herbicide application.

For soil temperature determination, a 3/8-inch steel rod was driven into the ground to 6, 12, 18, and 24-inch depths. A glass laboratory thermometer was carefully lowered into each hole. It was left in the hole at least 10 minutes, which allowed it to equilibrate with the temperature of the soil. When removed from the hole, the thermometer was immediately read and the temperature recorded. Average soil temperature for the site was determined from three replications at each depth.

Soil water content was determined from gravimetric samples taken in 6-inch increments to a depth of 24 inches. The average percent water for each site was determined from two replications.

The sites were aerially sprayed between June 9 and June 25, 1970, either by airplane or by helicopter as part of a commercial application of Tordon 225 Mixture, which was applied under an experimental label for Texas. Tordon 225 Mixture is the triethylamine salt formulation of picloram and 2,4,5-T in combination (1 lb a.e. each/gal). Each chemical in the mixture was applied at 0.25 lb a.e./acre in a total volume of 4 gal/acre. The commercial herbicide mixture was composed of a diesel: water emulsion (1:3). Triad[1] (a surfactant) was included in the mixture at a rate of approximately 1 oz/acre.

Root kills for each marked tree were determined in October, 1971, following the second growing season after herbicide application. Trees were considered dead if no evidence of sprouts or live tissue could be found.

Results

Environmental factors affecting mesquite mortality from 2,4,5-T (Dahl et al, 1971) also affected mesquite mortality from Tordon 225 Mixture. Root mortalities as high as 92% were observed on sites with soil temperature above 75°F at a

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The authors are assistant professor, associate professor and research associate, Department of Range and Wildlife Management, Texas Tech University, Lubbock. (College of Agricultural Sciences Publication Number T-10-108. Texas Tech University.)

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[1] Use of trade names is for the convenience of readers and does not constitute endorsement by the authors or Texas Tech University.

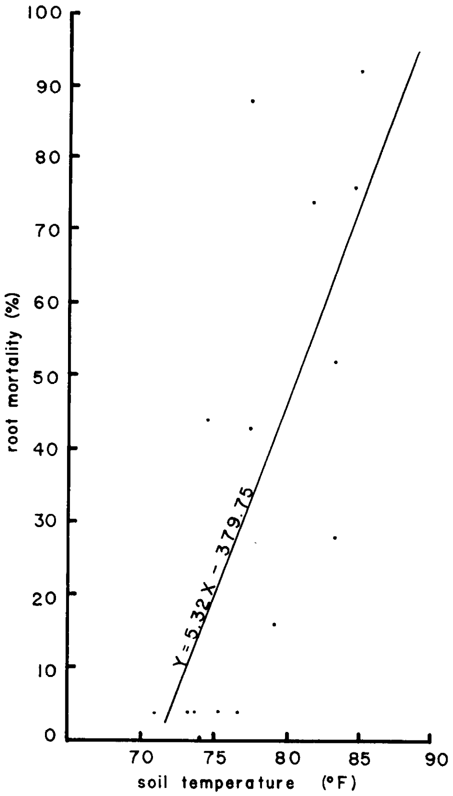

Fig. 1. *Relationship of average soil temperature at the 18-inch depth to average mesquite mortality from Tordon 225 Mixture applied in 1970. Average based on 25 trees on 15 sites (except one, which is the average of 23 trees). Mortality was determined following the second growing season after herbicide application.*

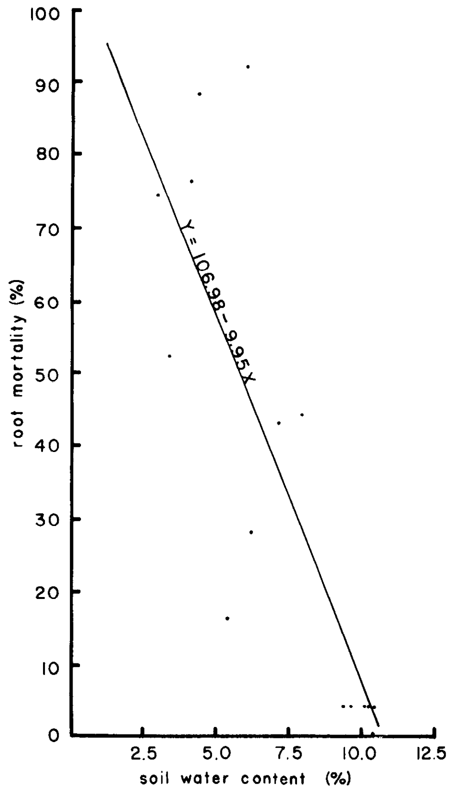

Fig. 2. *Relationship of average surface (0–6 inches) soil water content to average mesquite mortality from Tordon 225 Mixture applied in 1970. Average is based on 25 trees on 15 sites (except one, which is the average of 23 trees). Mortality was determined following the second growing season after herbicide application.*

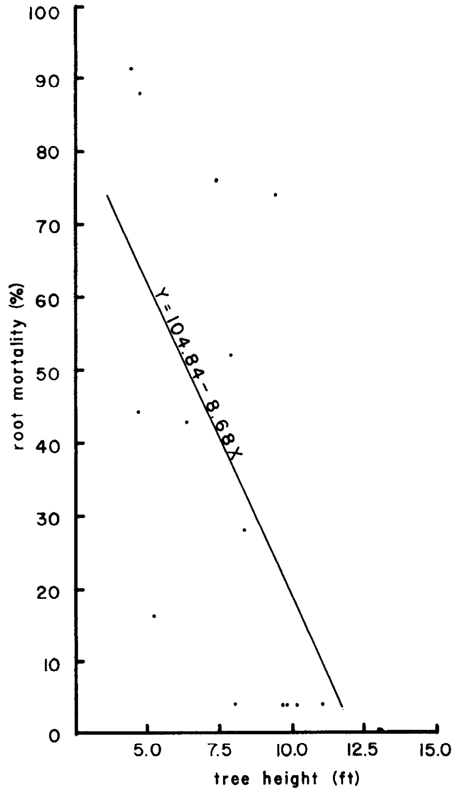

Fig. 3. *Relationship of average tree height of average mesquite mortality from Tordon 225 Mixture applied in 1970. Average is based on 25 trees on 15 sites (except one, which is the average of 23 trees). Mortality was determined following the second growing season after herbicide application.*

depth of 18 inches (Fig. 1). However, on some sites with soil temperature (18-inch depth) above 75°F, low percentages of root mortality were obtained; apparently because of the physiological processes occurring in the trees independent of soil temperature at the time of herbicide application. Root kill was characteristically low for sites with cool soils.

Soil water content to 24-inch depths was important in influencing mesquite mortality, although the relationship was negative. Limited amounts of soil water in the surface soil (0 to 6 inches) was most highly correlated with root kills (Fig. 2). With two factor multiple regression analysis, water content in the surface soil and the soil temperature at 18 inches accounted for 67% of the variability in the root mortality.

Trees taller than 8 ft were difficult to kill with aerial applications of Tordon 225 Mixture (Fig. 3). Large trees growing in dense stands shaded the soil, resulting in cooler soils and higher percentages of soil water. Tree height and soil temperature at 18 inches accounted for 65% of the variability in root kill and tree height and water content of the upper 6 inches of soil accounted for 67% of the variability.

Other measured environmental factors, stage of phenological development, and abundance of flowers did not significantly affect root mortality from Tordon 225 Mixture. No difference in mesquite mortality was detected between those sites sprayed either by airplane or by helicopter.

Discussion and Conclusion

All trees included in this study were sprayed at least 60 days after the leaves emerged from the bud. Although this is the only criteria commonly used for determining optimum spraying date, other criteria should also be evaluated. Physiological activities of plants are very well attuned to the environmental conditions that prevail over their native habitat. Therefore, all environmental conditions and phenological development should be considered when determining optimum conditions for spraying.

Honey mesquite control with Tordon 225 Mixture was closely correlated to the environmental conditions. Generally, mesquite mortality was greater when soil water content was low and soil temperature was above 75° F. Recent studies of site characteristics influencing mesquite kill with 2,4,5-T revealed that soil temperature is the most important environmental parameter. Root kills never exceeded 12% on sites with soil temperature less than 75° F at 12- to 24-inch depths (Dahl et al., 1971; B. E. Dahl, Ronald E. Sosebee, and John P. Goen, unpublished data). Therefore, for best results, it has been recommended that 2,4,5-T be applied when the soil temperature 12- to 14-inches deep exceeds 74° F.

Table 1. Summary for the 15 sites sprayed with Tordon 225 Mixture in 1970. Root mortalities were determined following the second growing season after herbicide application.

Site number	Site description	Form of aerial application	Soil temperature at 18-inches (°F)	Root mortality (%)
1	Deep hardland	Airplane	75	44
2	Bottomland	Airplane	74	4
3	Sandy upland	Airplane	77	88
4	Shallow upland	Helicopter	79	16
5	Bottomland	Helicopter	73	4
6	Bottomland	Helicopter	71	4
7	Shallow upland	Helicopter	85	76
8	Upland	Helicopter	77	43[1]
9	Deep hardland	Helicopter	75	4
10	Upland	Helicopter	85	92
11	Upland	Helicopter	82	74[1]
12	Deep hardland	Airplane	77	4
13	Shallow upland	Airplane	83	52
14	Bottomland	Airplane	74	0
15	Deep hardland	Airplane	83	28

[1] Average was determined from 23 trees. Two trees on each site had been destroyed.

When each site is viewed with respect to its soil temperature at 18 inches using Dahl's (1971) criteria, we could have anticipated the results obtained in this study with few exceptions (Table 1). However, the correlation of mesquite root kills from Tordon 225 Mixture to soil temperature was not as high as it was when 2,4,5-T was applied alone. We believe this is due to confounding of the effects of soil temperature with stage of mesquite growth. It is generally accepted that no root kills are obtained when growth-regulating herbicides are applied during periods when stored carbohydrates are being depleted, such as at the time of spring bud burst and leaf enlargement (Crafts, 1953; Fisher et al., 1959; Crafts and Crisp, 1971). Apparently herbicides are not moved to the roots in quantities sufficient to effect root kill during periods when stored carbohydrates are being depleted, regardless of soil temperature. Fisher et al. (1959) and Wilson and Dahl (1971) found that carbohydrates were fully restored to mesquite roots within 3 to 4 weeks after the time of maximum depletion. When the carbohydrate level of roots is fully restored, the basal region cannot act as a carbohydrate sink; consequently, neither carbohydrates nor herbicides move from the leaves to the root storage area (Crafts and Crisp, 1971). Wilson and Dahl's study also showed that the carbohydrate level in the roots of trees with many reproductive organs was more slowly restored than in the roots of trees with few or no flowers or pods. Therefore, we postulate that translocation to the roots either slows down or stops during reproduction, rendering applied herbicides ineffective as root killers.

Herbicide applications during this study were made when the carbohydrate level in the roots, particularly of those trees with few flowers and pods, should have been fully restored. Apparently, on sites with optimum soil temperatures trees that were not killed had reached the stage in their seasonal growth when carbohydrate translocation to the roots had ceased. For example, the 16% root kill obtained from site 4 was much lower than expected, using soil temperature as a guide. However, delaying application until later in the season gives sites ordinarily too cold for good herbicide control of mesquite time to warm up to a desired temperature (e.g. site 15). If no confounding results from lack of carbohydrate translocation later in the season, then it would be advantageous to wait until cooler sites have had sufficient time to warm up. However, by the time the soils of many of the colder sites have had time to warm up to a desirable temperature, the plants growing on warmer sites no longer are in the phenological stage most responsive to herbicides.

Soil temperature also depends upon the water content of the soil. Soils with a lower water content warm up sooner than those with a higher water content; hence, the negative relationship between soil water content and mortality rates.

Another important factor influencing root mortality in this study was tree height. Trees taller than 8 ft had lower mortality rates than did trees under 8 ft tall. With one exception (site 11) the taller trees occurred on the bottomland and deep hardland sites in very dense stands (more than 700 trees/acre). The soil temperature of most of these sites ranged from 71° to 77° F, marginal at best for optimum spraying conditions. Shading undoubtedly prevented higher soil temperatures, since in very dense stands of mesquite only sun flecs penetrated the canopy and reached the soil surface.

Possibly, tree height was also correlated with herbicide coverage. The leaves of the lower branches may not have received adequate coverage of the herbicide, especially in very dense stands. Each branch and stem is served primarily by its own vascular system to the basal bud zone and roots (R. B. Wadley, unpublished data). Therefore, those parts of the tree served by a particular branch or stem not receiving any herbicide would remain alive. The tree would, therefore, easily sprout from the basal bud zone or the stems and continue to live.

The effectiveness of Tordon 225 Mixture is directly related to the environmental conditions and stage of phenological development existing at the time of herbicide application. However, studies over a more extended period are needed to determine the optimum time for spraying with Tordon 225 Mixture.

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