Low-energy Grubbing with Special Blade to Control Algerita

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Algerita (*Berberis trifoliolata* Moric) infestations on low stony hill range sites in the Edwards Plateau vegetational area of Texas are a problem following primary brush control. Infestations appear well suited to control by low-energy grubbing. A feasibility study indicated the method was economical but plant kill was erratic. Sprouting of lateral roots near the periphery of the grubbed hole accounted for 56% of the regrowth while 13% was attributed to crown tissue attached to taproots. No sprouts originated directly from taproots. Remaining regrowth resulted from problems with blade penetration in the soil. To prevent sprouting, severing the taproot below the crown and uprooting of all lateral roots under the entire plant canopy to a depth of 10 to 15 cm was necessary. Grubber blade modification included an increase in width to 180 cm and an addition of small fins welded on top of the blade to increase plant uprooting. Grubbing with the modified blade resulted in a plant kill of 93% ± 3.5 (x ± S.D.) when tested in an algerita infestation of 42 to 195 plants/ha ranging in height from 1.0 to 1.5 m. The grubber averaged 2.13 ha/hr in a 110 plants/ha infestation and cost of $16.43/ha. The ha/hr grubbing rate (Y) plotted against trees/ha densities (X) followed the prediction equation log $\hat{Y}$ = 1.93 – 0.83 log X with a significant (P<0.01) correlation coefficient of r = 0.91. Low-energy grubbing using the modified grubbing blade is an effective and economical method of controlling algerita.

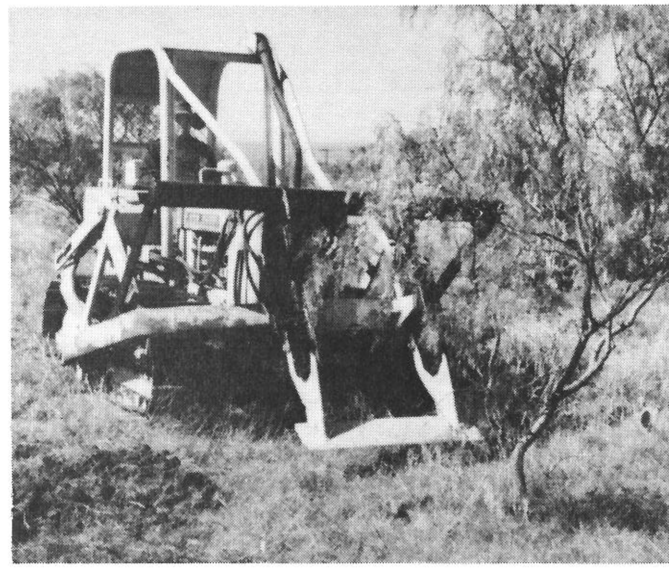

Fig. 1. *Low-energy grubber developed by Texas Agricultural Experiment Station engineers to uproot small trees. The 48.5 kW (65-hp) crawler tractor was equipped with a special blade 90-cm wide for grubbing.*

Algerita (*Berberis trifoliolata* Moric), also called agarito, is an evergreen shrub with spiny, holly-like, trifoliate leaves. (Correll and Johnston, 1970). It grows on dry stony hills to a mature height of 2 to 3 m. Texas has 1.82 million hectares of algerita infested rangeland with heaviest concentrations (up to 300 plants/ha) in the Edwards Plateau vegetational area (Soil Conservation Service 1973). Implementation of brush control programs, mainly aerial spraying and chaining, in the Edwards Plateau region has increased the prominence of algerita because it is highly resistant to liquid herbicides (Scifres and McCall 1975; Fisher et al. 1975). Root plowing gives effective control, but is costly (Fisher et al. 1972). Thus an economical method of algerita control is critically needed. Previous research has shown that a small crawler tractor equipped with a front-mounted U-shaped blade was a practical, low-cost method for effectively controlling small trees (Wiedemann and Cross 1975). The method, known as low-energy grubbing, has successfully controlled sparse to moderate stands of honey mesquite *(Prosopis glanulosa* Torr. var. *glanulosa)* Wiedemann et al. 1977) and junipers (Junipers spp.) (Wiedemann and Cross 1981). Algerita infestations appear well suited for control by low-energy grubbing; therefore, a study was conducted to determine 1) plant-kill effectiveness and 2) per-hr grubbing rates and cost in various plant densities.

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Mention of trade name is for identification only and does not imply an endorsement or preference over other products not mentioned.

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Materials and Equipment

Study Area

The study sites were located on the Gene Whitehead Ranch near Menard, Texas in the Edwards Plateau vegetational area. Climate in this region is semi-arid with 55 cm average annual rainfall. Soils were a mixture of Tarrant series and Tarrant-Kavett complex located on gentle slopes of 1 to 6%. These soils were characterized by a shallow layer of dark, grayish-brown clay about 15 cm thick containing numerous, small limestone fragments. Below this was a layer of larger limestone fragments, gravel and stones accounting for 855 of the total material. Outcropping of hard layers of limestone were occasionally present on steeper slopes. Range site classification was low stony hill. Algerita densities ranged from 40 to 300 plants/ha on these soils and plant height was 1 to 1.5 m.

Low-energy Grubber

The low-energy grubber was a John Deere 450-B, shift-on-the-go, 48.5-Kw (65-hp) crawler tractor equipped with a front-mounted, U-shape blade developed by the Texas Agriculture Experiment Station (Fig. 1). The sharp blade, mounted directly to the tractor's C-frame, was designed to sever roots 15 to 30 cm below the soil surface. Equipment details have been reported by Wiedemann et al. (1979) and Wiedemann and Cross (1981). An operator-activated counter was attached to grubber controls for counting plants grubbed and operating time was determined by recording clock time. Tractor cost of $35.00/hr was based on normal charges by reputable conservation contractors during 1981.

Fig. 2. *Algerita taproot with attached crown tissue sprouting 13 months following grubbing. Taproots without crown tissue did not sprout.*

Feasibility Study

A feasibility study was undertaken to determine the efficacy of the low-energy grubber to control algerita. The study area was divided into 3 plots of 4.1, 15.9, and 4.1 ha with 112, 212, and 333 algerita plants/ha, respectively. The algerita infestation had developed following aerial spraying, chaining and raking of native brush. Grubbing was conducted in May 1974 during high soil moisture conditions. The situation favored plant sprouting and provided a more severe test. Live and dead grubbed plants were counted in belt transects from each plot (~ 100 plants) to determine percentage plant kill.

Machine Response

The plot average of 2.25 ha/hr and cost of \$6.67/ha (1974 contract cost of \$15/hr) was considered to be very efficient and economical, but control was erratic. The limestone fragments did not present an unusual wear problem; however, the hard limestone outcropping occasionally hampered blade penetration. The technique appeared practical if plant kills could be improved.

Plant Response

Plant kills 13 months after treatment were 94, 80 and 65% for the 112, 212 and 333 plant/ha plots, respectively. One hundred individually grubbed holes with live plants were inspected to determine the origin of plant growth. Classifications of growth for evaluation purposes were (1) taproots with no crown tissue, (2) taproots with crown tissues, (3) severed lateral roots, (4) plant tops severed at ground level, and (5) plants transplanted (roots severed about 30 cm deep and undisturbed soil around roots).

No regrowth was present on taproots severed below the crown; however, if any crown tissue remained on the taproot—sprouting was present from this tissue (Fig. 2). This condition accounted for 13% of total regrowth. Plant tops severed at ground level (failure of blade to penetrate soil or operator error) resulted in vigorous sprouting and accounted for 28% of regrowth while transplanting (grubbing too deep and not disturbing soil around the roots) accounted for only 3% of regrowth.

The predominate problem, 56% of regrowth, originated from sprouting lateral roots around the periphery of the grubbed hole. Soil removal from the root system of undisturbed live plants revealed that these lateral roots originated at the crown and traveled laterally in the top 10 cm of the soil to some distance between origin and the edge of the plant's canopy where it gave rise to a plant stem, (Fig. 3). It was further observed that plants with canopy diameters smaller than the grubber's width (90 cm) were easily killed because the crown and all lateral roots were uprooted. Individual plants, or more often, groups of plants (mottes) with canopy diameters of 1 to 3 m were the predominate areas where regrowth occurred.

Fig. 3. *Lateral root originating from algerita root crown extending laterally as far as the edge of plant's canopy; then it gave rise to a plant stem. These lateral roots will sprout to form new plants when severed unless completely uprooted.*

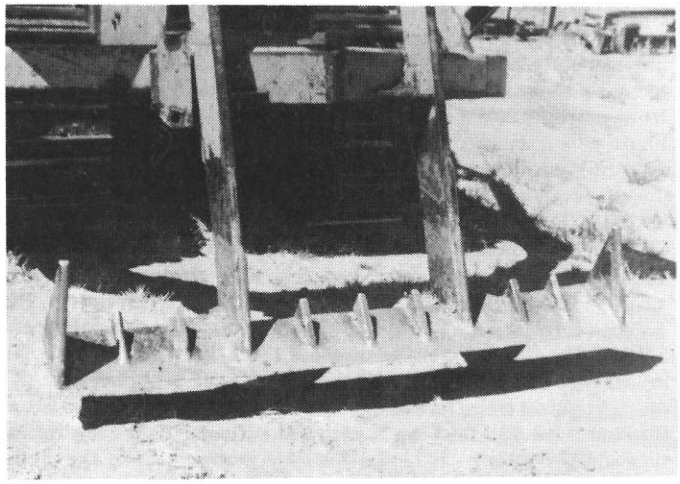

Fig. 4. *Low-energy grubber modified by addition of 180 cm grubbing blade with small fins every 15 cm to help insure uprooting of all lateral roots under entire plant canopy when grubbed at a depth of 10 to 15 cm.*

We then hypothesized that grubbing to depth of 10 to 15 cm under the entire plant canopy with good uprooting action was necessary for effective plant kill. Equipment and grubbing technique was modified based on this hypothesis and was the basis for performance study.

Grubber Modification

Since the grubber blade did not need to penetrate the soil beyond 15 cm, the 48.5 kW crawler tractor provided sufficient power to operate a wider than normal blade. The standard, 90-cm blade was extended to a width of 180 cm and small fins 8-cm tall were welded on top of the blade every 15 cm to increase uprooting action. The modified blade was buttwelded to a standard grubber frame and mounted to the outside C-frame (Fig. 4). Since little power was required to sever the small algerita root system, the hydraulic attachment was not necessary. Moreover, grubbing with the extra wide blade on the hydraulic unit would cause undue breakage of the rotating mechanism.

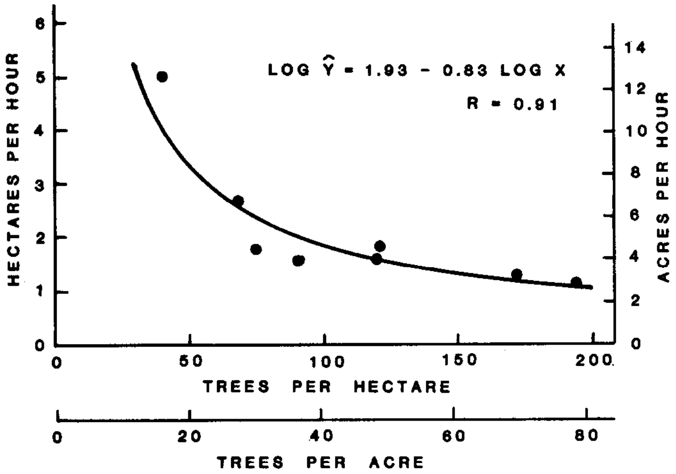

Fig. 5. *Per-hr performance (Y) of low-energy grubber with modified blade in various densities (X) of algerita plants 1- to 1.5-m tall; Ŷ, X based on metric units.*

Performance Study

The study area consisted of 8, 4.0-ha plots with algerita densities of 42 to 195 plants/ha. Plant height range from 1 to 1.5 m. The infestation developed following hand clearing of mesquite and associated species over the past 20 years on a location with the same soil type as the feasibility study. Grubbing was conducted in July 1976. Plant kill or regrowth was evaluated in the belt transects 13 months following treatment. Plots were spot checked at 24 and 36 months following treatment for reliability of initial evaluation. Regression analysis was applied to evaluate the relationship between ha/hr grubbing performance (dependent variable) and plant/ha densities (independent variable). Highest correlation coefficient (r) determined the best-fit curvelinear line.

Average plant kill using the modified grubber blade to insure lateral root disturbance was 93% ± 3.5 (x ± S.D.). Lowest plant kill percentage, 88%, occurred in the plot with the least number of plants/ha; a condition resulting from a very shallow soil with numerous outcroppings of hard limestone which prevented the grubber blade from penetrating the soil the necessary 10 cm. All other plots were in deeper soils and the small fragments of limestone did not hamper the grubber's operation. Of the 7% average regrowth, lateral roots sprouting around the periphery of the grubbed hole accounted for 4 percentage points while taproots with crown tissue (grubbing too shallow, <10 cm) accounted for the remaining 3 percentage points. Lateral sprouting was most prevalent where motte growth patterns existed.

These data strongly suggest that our hypothesis was correct i.e., grubbing to a depth 10 to 15 cm and uprooting of all lateral roots under the plant canopy was necessary for algerita plant kill. Spot checks of plant kills 24 and 36 months following treatment confirmed the original 13-month data.

The ha/hr grubbing rate (Y) plotted against trees/ha infestation (X, independent variable) follows the prediction equation $\log \hat{Y} = 1.93 - 0.83 \log X$ with a significant ($P<0.01$) correlation coefficient of $r = 0.91$ (d.f. 6), Fig. 5.

Average speed was reduced by the new grubbing technique (3.2 plants/min ± 0.6 ($\bar{x}$ ± S.D.) as compared to 7.2 plants/min in the feasibility study). This is not alarming because the tedious uprooting of all lateral roots was more time consuming and the same procedure with the narrow blade would have substantially reduced its plants/min output. Average productivity was still high, 2.13 ha/hr, in the overall density of 110 plants/ha, which is representative of most infestations in this area. Based on the 1981 contract price of $35/hr, the average cost for low-energy grubbing was $16.43/ha.

Conclusion

Severing the algerita taproot below the crown and uprooting all lateral roots originating from the crown was necessary to ensure plant kill. This was accomplished by grubbing to a depth 10 to 15 cm under the entire canopy area. The new grubbing technique and modified blade resulted in 93% plant kill.

Grubbing rates were 3.4, 1.9 and 1.1 ha/hr for densities of 50, 100 and 200 plants/ha, respectively, based on the prediction equation developed from plot data. Treatment costs per ha were $10.29, $18.42 and $31.82, respectively, based on 1981 rate of $35/hr.

Low-energy grubbing with the modified blade was an effective and economical method of controlling algerita. Since this method was suitable for controlling other major brush species in this region (Wiedemann and Cross 1980), low-energy grubbing has enhanced its suitability for maintaining previously cleared rangelands in the Edwards Plateau.

Literature Cited

Correll, D.S., and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Tex. Res. Foundation. Renner, Tex. p. 655.

Fisher, C.E., C.H. Meadors, J.H. Brock, and B.T. Cross. 1975. Effectiveness of aerially-applied herbicides for control of mesquite and associated brush species in western and southern areas of Texas. Rangeland Resources Research 1971-74. Texas Agr. Exp. Sta. Consol. PR 3341:28.

Fisher, C.E., H.T. Wiedemann, J.P. Walter, C.H. Meadors, J.H. Brock, and B.T. Cross. 1972. Brush control research on rangeland. Texas Agr. Exp. Sta. MP-1043:12.

Scifres, C.J., and H.G. McCall. 1975. Comparative response of woody plants to esters and salts of 2,4,5-T + picloram. Rangeland Resources Research 1971-74. Texas Agr. Exp. Sta. Consol. PR 3341:23.

Soil Conservation Service. 1973. Acres of grassland infested in woody species—1973 survey. USDA, SCS, Temple, Tex.

Wiedemann, H.T., and B.T. Cross. 1975. Low-energy grubbing for economical control of small trees. Rangeland Resources Research 1971-74. Texas Agr. Exp. Sta. Consol. PR 3341:35-36.

Wiedemann, H.T., and B.T. Cross. 1980. Performance of low-energy grubber for control of selected brush species. Rangeland Resources Research 1971-1974. Texas Agr. Exp. Sta. Consol. PR 3665:96-98.

Wiedemann, H.T., B.T. Cross, and C.E. Fisher. 1977. Low-energy grubber for controlling brush. Trans. of ASAE 20 (1):210-213.

Wiedemann, H.T., and B.T. Cross. 1981. Low-energy grubbing for control of junipers. J. Range. Manage. 34:235-237.

Wiedemann, H.T., J.E. Slosser, and B.T. Cross. 1979. Tree uprooting with a low-energy grubber for shelterbelt thinning. Trans. of ASAE 22(6):1275-1278.