

Low-energy Grubbing for Control of Junipers

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Abstract

Low-energy grubbing was effective and economical in controlling sparse to moderate stands of junipers infesting rangeland. A small, 48.5-kW (65-hp), shift-on-the-go crawler tractor, as compared to tractors larger than 74.5 kW (100-hp) normally used, was adapted for grubbing by attaching a U-shape blade to the front mounted C-frame for root cutting at depths of 15 to 30 cm. A 98% plant kill was achieved because uprooting of trees below the bud-zone prevented sprouting. The newly designed hydraulic attachment significantly improved tree uprooting. Grubbing rate was a curvilinear function of juniper density and varied approximately from 4.0 to 0.5 ha/hr (10 to 1.25 ac/hr) to remove 80 to 500 trees/ha (30 to 200 trees/acre). Cost varied from \$6.00 to \$50.00/ha (\$2.40 to \$20.00/acre).

Mixed stands of redberry and ashe juniper (*Juniperus pinchoti* Sudw. and *Juniperus ashei* Buchholz) infest approximately 7.6 million ha of Texas grassland (Soil Conservation Service 1973). Control of these invaders is a major concern of ranchmen in the Rolling Plains, Edwards Plateau, and Cross Timbers and Prairies vegetational areas. The rapid spread of juniper, 1.4 million ha increase between 1948 and 1963 (Smith and Rechenstien 1964), has been attributed mainly to birds and rodents (Phillips 1910). Juniper stands rapidly increase in density and soon reduce grass cover and hamper livestock operations (Smith and Rechenstien 1964). Robison and Cross (1970) determined that control of dense stands of junipers increased oven-dried forage production from 410 to 1,547 kg/ha in the Edwards Plateau.

Grubbing and chaining are the principal methods of control; however, hand cutting was widely used in the 1930's for control of ashe juniper. Chaining is very economical but results vary from fair to good control. Chaining is most effective on large trees in loose, shallow, or moist soils where trees are easily uprooted, or in stands of ashe juniper (Rechenstien et al. 1964). Control of ashe juniper is relatively easy since there are no buds on the trunk and regrowth does not occur when all green limbs are removed. Redberry juniper, however, will resprout unless the entire stump is severed below the bud-zone, which occurs near groundline (Wolff 1948).

Power grubbing involves uprooting of trees with a U-shape blade attached to the front mounted C-frame of a crawler tractor. The technique is also referred to as "dozing" or "bulldozing". Dozing normally indicates that a small U-shape blade is attached to the bulldozer blade for uprooting or the bulldozer alone is used to shear the plant at ground line.

Power grubbing for brush control with a bulldozer was introduced in 1938 by a North Texas ranchman (Dickson et al. 1940). To improve the percentage of trees killed, a "stinger" was developed, in cooperation with the Texas Agricultural Experiment

Station, which attached to the bulldozer blade and severed the stump below ground with less soil disturbance. Refinements have resulted in the present day, U-shaped blade attached directly to front mounted C-frames on 74.6 kW (100 hp) or larger crawler tractors. They operate efficiently in sparse to moderate stands of large trees at a rate of 0.4 to 1.2 ha/hr (Fisher et al. 1959, Wiedemann 1971).

More recently, low-energy grubbing with a 48.5-kW (65-hp) crawler tractor has resulted in a highly efficient method for controlling small mesquite trees (*Prosopis glandulosa* Torr. var. *glandulosa*) Wiedemann et al. 1977). It averaged from 1 to 4 ha/hr in densities of 80 to 250 trees/ha and was more economical than a 89.5-kW (120-hp) unit. A unique, hydraulically controlled blade angle adjustment was developed to split stumps or loosen the roots which increase tree-size grubbing capacity by at least 1/3 (Wiedemann et al. 1977, Wiedemann et al. 1978). Low-energy grubbing has also been effective and economical in controlling moderate stands of huisache (*Acacia farnesiana* (L.) Willd.) (Bontrager et al. 1979).

Sparse to moderate stands of juniper appear well suited to low-energy grubbing technique of control. The objectives of this study were to (1) determine the per-hr grubbing rates and costs for various juniper densities, (2) determine plant kill effectiveness, and (3) evaluate performance between standard and hydraulic grubbers.

Materials and Equipment

Research Site

The study area was located on Tarleton State University's Hunnewell Ranch, east of Stephenville, in the Cross Timbers and Prairies vegetational area of Texas. Soils were classified as Malotterre or Purves-Dugout complex. These shallow, calcareous, gravelly, clay to clay loam textured soils were underlain with a limestone layer 10 to 30 cm below the surface. Outcropping of the limestone layer often gave a distinct benched or stairstep appearance to the area. Juniper densities range from 50 to 600 plants/ha on these soils with trees ranging from 0.3 to 5 m tall. Sparse stands (<250 trees/ha) of trees 0.3 to 1.8 m tall are more prevalent on the shallower Malotterre soil. A moderately deep Windthorst fine sandy loam site supporting a sparse stand was also selected to represent infestations in improved pastures. Both redberry and ashe juniper were present on each soil site.

Low-Energy Grubber

A John Deere 450-B, turbocharged, shift-on-the-go, 48.5-kW (65-hp) crawler tractor with an outside-mounted angle dozer (no. 6410) and ROPS canopy (Roll-Over Protection Structure) with brush protection option was adapted for grubbing (Fig. 1). The sharp, U-shape blade was designed for root severing at 15 to 30 cm below ground. The special hydraulic attachment utilized two, 8.9-cm diameter, 25.4-cm stroke, double-acting cylinders to rotate the cutting blade approximately 70 degrees (Fig. 2). The unit was labeled "hydraulic" grubber for identification. A second grubber of the same size and shape without the hydraulic blade-angle adjustment was utilized and labeled "standard" grubber. Further grubber details are outlined by Wiedemann et al. (1977). Tractor cost of

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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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Fig. 1. Low-energy grubber developed by Texas Agricultural Experiment Station engineers to control small trees infesting rangeland. The small, 48.5-kW (65-hp), crawler tractor was adapted for grubbing by attaching special U-shaped blade to the front-mounted C-frame.

\$25.00/hr was based on normal charges by reputable conservation contractors for small crawlers during 1979. Charges were \$15.00/hr in 1974 when this study was conducted.



Fig. 2. Unique hydraulic attachment increases tree size uprooting capacity of low-energy grubber. Blade rotation of 70° results from extending the hydraulic cylinders and action aids in tearing roots loose and stump uprooting.

Experimental Procedure

Junipers were grubbed from 20, 1- to 5-ha plots during January 1974. Plot size was varied to assure at least 1 hour of grubbing time per plot. An operator-activated counter was attached to grubber controls for tree counting, and clock time was recorded before and after grubbing each plot. The same tractor and operator were utilized in all tests. Plant mortalities were determined 20 months following treatment. Counts of live, dead, and new seedling plants were taken in 1.8-m belt transects from each plot.

Regression analysis was applied to evaluate the relationship between grubbing time (dependent variable) and juniper density (independent variable). Highest correlation coefficient (r) was used to determine the best-fit relationship between linear and curvilinear (exponential) regression lines. Difference between grubbers was statistically evaluated by contrasting regression line slopes with a t -test.

Results and Discussion

Low-energy grubbing was highly effective in controlling juniper with plant kills averaging 98%. Those plants which resprouted

were not severed below the bud-zone because large fragments of limestone had prevented complete plant uprooting.

Sparse to moderate infestations averaging 259 junipers/ha were grubbed at a rate 2.0 ha/hr and cost \$12.50/ha. The average grubbing rate increased to 3.0 ha/hr in the sparse stands averaging 143 tree/ha but decreased to 0.8 ha/hr in moderate stands averaging 400 tree/ha. A significant ($P < 0.01$) correlation ($r = 0.96$, d.f. 9) existed between plant densities of 79 to 531 trees/ha (X) and grubbing rate (Y) when data was fitted to the curvilinear equation illustrated in Figure 3.

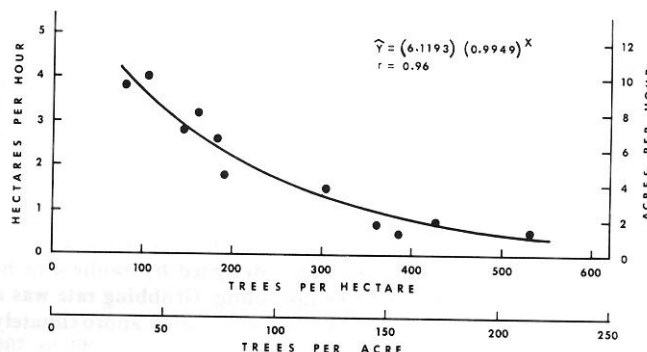


Fig. 3. Per-hour performance (Y) of low-energy grubber in various densities (X) of juniper trees 0.3- to 1.8-m tall; \hat{Y} , X based on per-hectare units.

Because of the underlying layer of limestone, junipers were all shallow rooted, and thus uprooting was simplified. This was especially true with large trees since the limestone layer acted as a footing for hydraulically activated blade rotation. After the blade was initially embedded in the base of the stump near the limestone layer, blade rotation effectively raised the stump from the soil. The number of trees grubbed/min (Y) by the hydraulic grubber remained at a higher level of performance than the standard unit as juniper densities (X) increased from 213 trees/ha (Fig. 4) and regression-line slopes were significantly different ($P < 0.025$). Since the hydraulic mechanism was not activated while grubbing junipers less than 1.2 m tall, its value will be more evident when trees are consistently larger. Additional analysis of the hydraulically assisted grubbing technique is covered by Wiedemann et al. (1978).

The numerous, small fragments (less than 10-cm long) of limestone encountered in the top soil did not deter blade penetration or grubbing action. In isolated cases, fragments were larger than 30 cm and these hampered uprooting. Fracturing of the limestone layer was not necessary for plant uprooting and should be avoided to prevent undue mechanical damage to the grubber. Shields on the grubber frame (Fig. 2) were necessary to prevent tree limbs from breaking the hydraulic hose fitting on the cylinders.

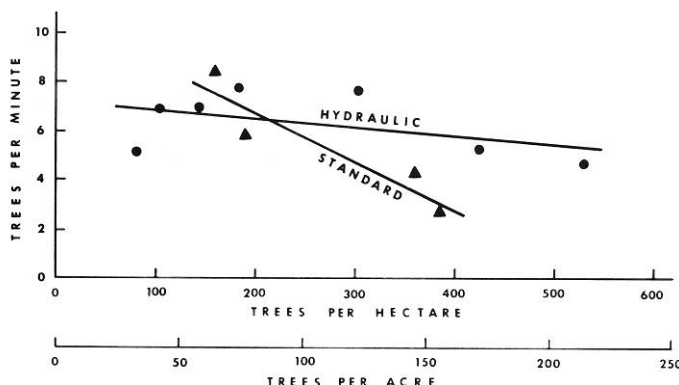


Fig. 4. Trees/min grubbing rates (Y) for hydraulic and standard grubbers in various juniper densities (X). Regression-line slopes were significantly different ($P < 0.025$) and the hydraulic grubber maintained a higher level of performance above 213 trees/ha.

Table 1. Low-energy grubbing of junipers under broad range of conditions near Stephenville, Tex.

Tree height (m)	Soil condition	No. tests	Trees/ha	Ha/hr	\$/ha ¹
0.3 to 1.8	5 to 20 cm of soil over layer of limestone	11	259	2.0	12.50
1.8 to 3.0	10 to 15 cm of soil over layer of limestone	4	54	1.8	13.88
1.0 to 1.8	deep sandy loam	1	207	4.0	6.25

¹Data based on \$25.00/hr contract tractor cost.

A potpourri of field tests with the hydraulic grubber were conducted to detect conditions where the prediction equation would be invalid. Data are presented in Table 1, and point out the need for additional research where trees are usually large or where soil conditions are favorable for much faster tractor speeds.

Predicted grubbing costs varied from \$6.00 to \$50.00/ha in the range of densities grubbed. The exponential cost curve is presented in Figure 5 using a contract tractor cost of \$25.00/hr. All per-hour grubbing rates represent maximum rates for short periods; therefore, a 75 to 85% field efficiency factor would be anticipated in commercial operation.

The low-energy grubbing technique appears well suited to controlling junipers 1- to 2-m tall in sparse to moderate stands. Although percentage kill of original plants was high, an average of 230 seedling/ha were observed 20 months following treatment. The original infestation averaged 254 plants/ha. Thus, follow-up treatment will be necessary in the future. Additional research to develop a rubber-tire tractor grubbing technique as a low-cost maintenance-type control practice for these small trees (<1.25 m tall) appears feasible.

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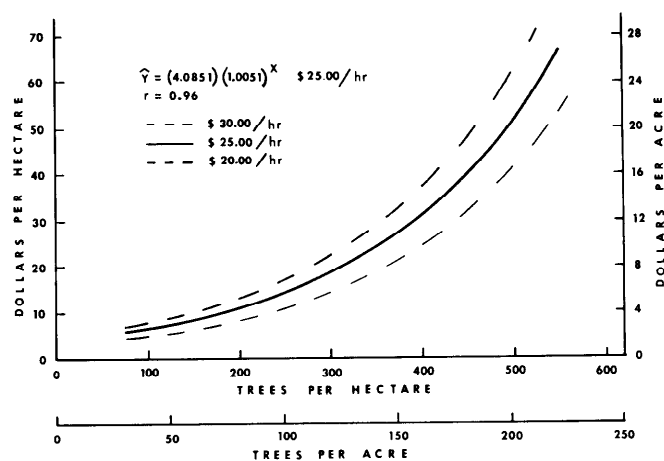


Fig. 5. Per-hectare and per-acre cost (Y) of low-energy grubbing at various density of junipers (X) 0.3- to 1.8-m tall based on a contract cost of \$25.00/hr. Since tractor costs often vary, rates of \$20.00 and \$30.00/hr are also illustrated. \bar{Y} , \bar{X} are based on metric units.

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