Development, Testing, and Evaluation of the Deep Furrow Drill Arm Assembly for the Rangeland Drill

JERRY E. ASHER AND RICHARD E. ECKERT, JR.

Highlight: A deep furrow drill arm assembly for a Rangeland drill was developed, tested, and evaluated. Horizontal disk angle was the single most important factor affecting construction of an adequate furrow. This angle varied among sites and was influenced by vegetative cover and soil conditions. The final design was an assembly with an adjustable disk angle. Seeding stands in deep furrows were equal to or superior to those in standard furrows.

Many workers have shown the value of deep-furrow planting for seedling establishment and survival in varied rangeland environments (McGinnies, 1959; Eckert and Evans, 1967; Evans et al., 1967, 1970; Hull, 1970; Klomp and Hull, 1972; and Eckert et al., 1973). In these studies, furrows were constructed with hand tools or with shovel-type openers not adapted to rough, rocky rangeland conditions.

A cooperative effort was initiated in 1968 to design, test, and evaluate a drill arm assembly for the Rangeland drill to make furrows with the desired microclimate characteristics and one also adapted to large-scale operations.

Development and Testing

In 1968, we modified one Rangeland drill by replacing the 20-inch disks with 24-inch disks. Four of the ten arm assemblies were removed, and the arms were reversed so that the disks cast to the outside. This arrangement resulted in row spacing of about 20 inches. With 100 lb weight on each arm, this equipment made good furrows in sandy and cultivated soils. In uncultivated, loamy soils, these arms could not support the additional weight of 400 lb required to cut an adequate furrow.

In 1969, the U.S. Forest Service Equipment Development Center fabricated two “heavy-weight” drill arms with 24-inch disks and capable of supporting 400 lb of “add-on” weight. These arms were tested on 350 acres, including a fire rehabilitation, a sagebrush spray-drill operation, and an atrazine fallow. On loam and clay-loam soils with rocks 5 to 15 inches in diameter, these arms with 400 lb of weight made furrows that averaged 3 inches deep and 4 inches wide at the top. The standard drill with standard weight (20 to 40 lb) made a furrow only 1 inch deep and 1 inch wide in moist soil and barely scratched the surface of dry soil.

Mechanical problems associated with weight additions were corrected, and six arm assemblies with 24-inch disks and various horizontal and vertical angles were tested in 1970. The horizontal angle is the pivot of the disk viewed from above. The vertical angle is the tilt of the
Disk viewed from above. No significant mechanical problems were encountered on 900 acres of extremely rough, rocky terrain on four sites. However, one very important fact became apparent. Small differences in disk angle drastically changed the weight requirement. For example, a disk at one angle with 80 lb cut a better furrow than a disk at another angle with 520 lb of "add-on" weight.

Construction of an adequate furrow was influenced by at least ten variables, the most important of which was the horizontal disk angle. Too much horizontal angle results in wide, shallow furrow and creates maintenance or breakage problems because the disk tends to dig at rocks and vegetation rather than roll over them. Conversely, with too little horizontal angle, the disk merely scratches the surface, and no furrow is cut. The disk angle required varies from site to site. Therefore, we recommended the manufacture of two adjustable disk-arm assemblies (Fig. 1).

The horizontal angle adjusts from 55 to 75° in 2.5° increments; the vertical angle adjusts from 4 to 18° in 2° increments. Adjustments on one arm can be made in 3 to 5 minutes. Conditions of vegetative cover and soil texture, moisture, or freezing, encountered indicated that adjustment once or twice a week was sufficient.

The new arms were tested on 1,300 acres in Nevada and Oregon in 1971. One 700-acre site was a mixture of rock-free and moderately rocky ground. On another site of 600 acres, 12- to 36-inch diameter rocks were encountered constantly. The adjustable arms could carry 200 lb of weight, yet only 100 lb were needed. Vertical angles used ranged from 4 to 6°; horizontal angles ranged from 60 to 67.5°. In all tests, the new arms made deep furrows with one-half the weight needed on fixed-angle arms.

So far only two minor disadvantages of deep furrowing have been noted. A drill-row spacing of 20 inches instead of 12 inches decreases plant density and perhaps reduces the soil-stabilization effect of the seeding. On many sites, however, this is the only effective seeding method, so there is really no comparison with the standard drill. More emphasis must also be placed on contour seeding because of furrow size.

Stand Evaluation

Seedling stands and stand establishment were compared in standard and deep furrows under different situations. Stands in deep furrows were equal to or superior to those in standard furrows. Stands were always superior in deep furrows under the more difficult seeding conditions. Superiority in deep furrows was indicated by larger, more vigorous plants; greater plant density and frequency; more seedlings headed; and greater survival. All these characteristics were not found in each comparison, but varied from site to site.

On a fire rehabilitation, frequency of crested wheatgrass (Agropyron desertorum) per ft of row was 20% in standard furrows, compared to 46% in deep furrows. Rhizomatous grasses and Sandberg bluegrass (Poa secunda) formed a dense sod. This sod was cut and lifted by the 20-inch disk on the standard drill, but after seeding, the sod dropped back to its original position covering the seed. The deep-furrow drill threw strips of sod completely out of the furrow.

On a 1,000-acre sagebrush spray-drill operation, the frequency and height of crested wheatgrass seedlings were 60% and 6 inches, respectively, in the deep furrow. Stand characteristics were 41% and 3 inches on areas seeded with disk assemblies that did not make adequate furrows. These disks, weighted with 200 lb, rolled over the top of the understory vegetation.

On four atrazine-fallow projects ranging from 80 to 1,200 acres, crested-wheatgrass seedlings were from 2.2 to 3.3 inches taller, survival was 13% greater, and 13% more of the seedlings produced reproductive culms in deep furrows than in standard furrows. Seedling densities of intermediate wheatgrass (Agropyron intermedium) and pubescent wheatgrass (A. trichophorum) were three to eight times more, height 0.5 to 2.4 inches greater, and frequency 43 to 51% higher in deep furrows than in standard furrows.

Summary and Recommendations

Since 1968, 2,300 acres on ten sites in four Bureau of Land Management districts in two states have been seeded with the deep-furrow technique. A standard Rangeland drill was the basis for comparison in most instances. Most testing was done under extreme operational conditions with no significant mechanical problems.

Seedling stands and stand establishment were generally much better in deep furrows. The standard drill was adequate on some sites; however, in uncultivated medium or heavy-textured soil, under rocky conditions, or where the understory was a sod of bluegrass, cheatgrass (Bromus tectorum), or rhizomatous grasses, the deep-furrow arm assembly was required to make an adequate furrow.

The U.S. Forest Service Equipment Development Center, San Dimas, California, has completed specifications for an adjustable, drill-arm assembly capable of making the desired type of furrow under a wide range of vegetation and soil conditions.

Literature Cited

Eckert, Richard E., Jr., and Raymond A. Evans.


Chemical Fertilization of Fourwing Saltbush

STEPHEN E. WILLIAMS AND GEORGE A. O’CONNOR

Highlight: Fourwing saltbush is an important member of arid and semiarid rangeland communities, supplying high quality forage for herbivores as well as serving as an erosion deterrent. Methods of saltbush establishment, however, have met with only limited success. Results of a greenhouse study show that small additions of balanced fertilizer can greatly increase saltbush growth and hence likely increase the probability of saltbush establishment. The results appear to warrant further study in the form of field tests to evaluate the practicality of large scale fertilization of saltbush plantings.

Fourwing saltbush (Atriplex canescens (Pursh) Nutt.) has long been recognized as an important member of arid and semiarid rangeland communities. It provides high quality forage for herbivores and serves as an important erosion deter-

The average dry weights of plants were not significantly (P = 0.05) different for saltbush grown on any soil when all soils were fertilized (Table 1). However, plants grown on the unfertilized under and between soils yielded significantly (P = 0.05) less than plants grown on the unfertilized garden soil. The addition of fertilizer to either the between or under soil resulted in significantly (P = 0.05) greater yields when compared to the west and 16 km south of the Federal Building in Albuquerque. The between and under soils were classified as the Las Lucas loam and were members of the fine-silty, mixed mesic family of Ustolic Cambisols. Samples were collected 3.2 km south of La Ventana, N. M., and 2.4 km due east of San Luis, N. M., just east of state highway 44 at the old Civilian Conservation Corps camp.

Approximately 180 kg of each soil type was collected from the top 15 cm of the profile. The soils were air dried and stored in metal garbage cans at room temperature. The soils were mechanically ground and larger chunks of organic material, soil aggregates, and rocks were removed.

The effect of small additions of fertilizer on the growth of saltbush was studied under greenhouse conditions. Thirty-six pots (diameter 23 cm and height 18.5 cm) were divided into three groups of 12 pots. Each group was filled with one of the three soils (about 7.2 kg of soil/pot). One gram of 12-12-12 fertilizer, equivalent to 22.8 kg N/ha, 10 kg P/ha, and 18.75 kg K/ha, was added to each of six pots from each group. The remaining six pots in each group constituted the control (no fertilizer) treatment. Seeds (100 per pot) were planted in a ring 3 cm from the outside of the pot and 1 cm below the soil surface. The fertilizer was banded about 2 to 2.5 cm immediately below the seeds.

The pots were randomly oriented in the greenhouse and watered 26 times with a total of 12.1 cm of water during the 97-day growth period, resulting in a favorable moisture regime for the seedlings. The locations of the 36 pots were randomly changed 20 times during the growth period to minimize temperature and light differences within the greenhouse.

Twenty-three days after emergence, all plants were thinned to nine plants per pot. Plants were thinned again at the end of another 43 days to maintain a population of nine plants per pot (only plants which had germinated since the first thinning were removed). At the end of 97 days, plants were harvested, dried at 75°C for 14 days, and weighed.

Results and Discussion

The average dry weights of plants were not significantly (P = 0.05) different for saltbush grown on any soil when all soils were fertilized (Table 1). However, plants grown on the unfertilized under and between soils yielded significantly (P = 0.05) less than plants grown on the unfertilized garden soil. The addition of fertilizer to either the between or under soil resulted in significantly (P = 0.05) greater yields when compared to the...