Power-Takeoff Rotary Digger for Establishing Cylindrical Field Microplots in Heavy-Textured Soils

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ABSTRACT

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A conventional pos.hole auger was modified to construct a circular trench about 4 cm wide by 25 cm deep, leaving a core of soil 122 cm in diameter. Fiberglass cylinders 30 cm deep by 120 cm in diameter were placed in the open trenches and the soil was firmed around the inside and outside surfaces. These field microplots were ideal for investigating the ecology and biology of soilborne pathogens over extended periods with ample and uniform replication and without cross-contamination problems. This digger, which is a modification of the microplot cutter designed for sandy soils, has performed well in rocky and heavy-textured soils with minimum disturbances to the soil profile.

Relating preplant population densities of soilborne pathogens to root-disease severity and crop yield (especially that of annual agronomic crops) has received considerable attention in recent years (3). Such data are needed for determining the economic threshold densities (4–7), which are essential for developing effective and practical control programs with Integrated Pest Management principles and strategies.

Field microplots are ideal for these types of studies because they provide marketable yield data under natural field conditions and permit the use of a large number of replicates with uniform population densities. Field microplots can also be used for detailed studies of the effects of biotic and abiotic soil and environmental factors on the ecology of soilborne pathogens and of the epidemiology of root diseases.

A major investment in time and cost is required for establishing and maintaining the microplots. Maintaining the test area with minimum disturbance to the soil profile, including the subsoil layer, is necessary to preserve the natural conditions of the soil environment. Barker et al (2) constructed a microplot cutter for this purpose, and the apparatus works very well for sandy soils. This paper reports on modifications we made using inexpensive materials to design an apparatus that is functional in the heavy-textured and often rocky soils of the northeastern United States.

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MATERIALS AND METHODS

The main part of the rotary digger was the frame and gearbox of a Ford Model 903 earth auger and a three-point hitch suitable for attachment to a farm tractor with a standard power-takeoff assembly. Instead of the conventional auger unit (Fig. 1A), a rotary digger was constructed and mounted to the gearbox drive shaft (Fig. 1B). The basic frame of the rotary digger consisted of four 4.7-mm-thick perforated steel plates (30 × 45 cm) connected by eight 4.7-mm-thick steel strips (5 × 80 cm) that formed a cylinder with a circumference of about 365 cm (Fig. 1B,C). Cutting teeth made from a 6.4-mm-thick steel angle iron (4.4 × 4.4 × 30 cm) were welded to each of the four perforated plates at a 45-degree angle (Fig. 1D). The pointed edges of the cutting teeth were ground to a 30-degree angle for cutting through compacted soil. The cutting frame was connected to a central shaft made of 7.9-mm-thick steel pipe (6.4 cm in diameter by 90 cm long) by eight 2.5-cm-diameter steel pipe braces (Fig. 1C). Four of the braces (55 cm long) were welded inside of and parallel to the top edge of the cutting frame. The other four braces (75 cm long) were welded to connect the top edge of the cutting frame to the base of the threaded portion at the upper end of the central shaft. A 15-cm-long steel bit was welded to the lower end of the central shaft. A steel close nipple (7.5-cm inner diameter) that fit over the gearbox drive shaft of the posthole auger was mounted on the upper end of the central shaft with a reducing coupling, which changed the central shaft diameter from 6.3 to 7.5 cm. A high-quality shear pin (11 mm thick, 10.8 cm long, and hardness #5) was used to affix the unit to the gearbox drive shaft.

The walls of the microplots were fiberglass cylinders made from sheets of clear, 0.9-mm-thick, Lascolite crystalite (0.16 g/cm^2) (Lasco Industries, Florence, KY). The cylinders were 30 cm deep by 120 cm in diameter. The ends of each cylinder were connected with 3.25-mm aluminum "pop" rivets with an overlap of about 8 cm. The cylinders were maintained about 5 cm above the soil surface (Fig. 1F).

RESULTS AND DISCUSSION

The rotary digger employs the same principle as a carpenter's hole saw and digs a circular trench about 4 cm wide by 25 cm deep, leaving a central core 122 cm in diameter (Fig. 1E). The trench stays open and clear of loose soil unless the soil is extremely dry. Also, disturbance to the soil profile, if any, has been very limited in our experience. The digger has been versatile because it performs well in light-textured soils as well as rocky and heavy-textured soils. Relatively small rocks and soil clumps are expelled by the slotted construction of the frame and the action of the outside cutting teeth. The action of the outside teeth may be improved by extending their length to match that of the plates on which they are mounted. A critical function of the steel bit at the end of the central shaft is to maintain stability of the unit, especially when the outside cutting teeth encounter a relatively large stone. The rotary digger should be maintained in a vertical plane while cutting and should be operated at low speed in rocky and heavily compacted soils.

After inserting the fiberglass (0.9 mm thick) cylinders, it is important to firm the soil surface both inside and outside the microplots. Failure to do so may result in gaps between the soil and the fiberglass surfaces that would channel water away from the microplots. These fiberglass cylinders can be maintained for several years without damage during the harsh winter conditions that prevail in the northeastern United States. Previously, unglazed clay tiles installed by posthole auger have been used (1,2,8) and have functioned quite adequately; however, they are much smaller and must be removed and stored every winter.

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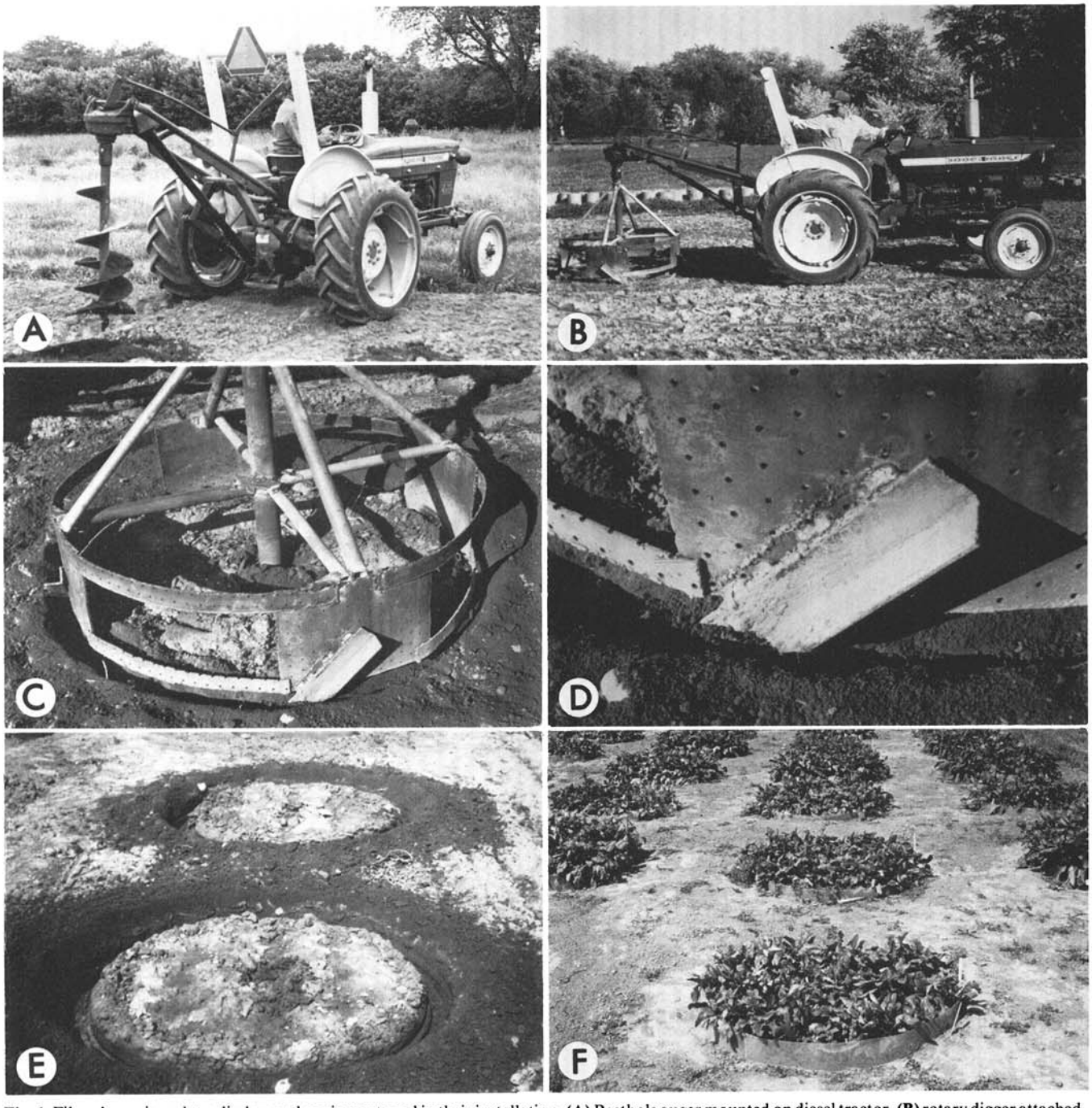

Fig. 1. Fiberglass microplot cylinders and equipment used in their installation. **(A)** Posthole auger mounted on diesel tractor, **(B)** rotary digger attached to auger gearbox and same tractor, **(C)** close-up of rotary digger frame, **(D)** close-up of an outside cutting tooth, **(E)** fresh trench dug by rotary digger, and **(F)** microplots spaced 210 cm apart.

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