Tillage Techniques for Gardens and Small-scale Vegetable Production

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ABSTRACT

Sandy soils of the Coastal Plain and Applachian Plateau can develop traffic pans or hardpans as a results of some conventional tillage practices. Techniques for disrupting these traffic pans are well documented for field crop production. However, gardeners and small-scale vegetable producers can experience the same problems when using garden tillers. Slit tillage using a modified, 5-hp, garden tiller in a sandy, Coastal Plain soil significantly increased yields of sweet corn, okra, and southern peas over more conventional tillage practices such as using a standard, front-tined or rear-tined garden tiller. Slit tillage disrupted traffic pans, reduced in-row soil compaction, and resulted in yields as high or higher than traditional subsoiling. Slit tillage may offer the home gardener and small farmer a low-cost solution to a soil compaction problem created by conventional tillage practices. Additional techniques such as double digging and manual slits using a spade are being evaluated for use by the home gardener in reducing the damaging effects of subsoil compaction.

KEYWORDS

Darden tillage, slit tillage, vegetable, garden, traffic pan, soil compaction, hardpans

INTRODUCTION

Traffic pans or plow pans in Coastal Plain soils of the southeastern U.S. are a common problem in non-irrigated field crops. Traffic pans are a thin layer (2 to 4 inches) of compacted soil resulting from the downward force of tillage equipment on the soil just beneath the plow layer. The problem is particularly serious on soils with a sandy topsoil (Ap horizon) just above a finer textured subsoil. This situation is common on soils of the Coastal Plain and Appalachian Plateau (e.g. Sand Mountain).

Many large-scale producers routinely subsoil their fields prior to or at planting to create a deeper rooting zone for non-irrigated crops. In order to reduce the energy needed for this operation, innovative techniques such as "slit tillage" have been proposed. Slit tillage uses a blade to cut a narrow slit through the traffic pan, which roots can follow into the subsoil. Root channels through this slit persist from year to year if the soil is not drastically disturbed. Unfortunately, coarse textured, sandy soils tend to rapidly wear away a blade. Therefore, slit tillage has not become a practice for large-scale farmers.

Traffic pans or tillage pans may also be a problem for gardeners and small-scale vegetable producers. These growers probably don't have access to large equipment necessary for deep tillage and subsoiling. Often they depend on small tractors with disks and/or garden tillers, which may create traffic pans as serious or worse than those created by field cropping practices. In fact, estimates of soil compaction by common activities rank tillers among the most serious.

Source of Compaction	Estimated compaction
	lbs inch^{-2}
Man walking	6
Crawler-type tractor	12
Wheel-type tractor	20
Cattle	23
Horse	40
Garden rototiller	107-750

The faster the tines of a tiller rotate, the more energy is transferred into the soil just beneath the tines. This rapid rotation of a rear-tined tiller has the potential to create traffic pans more severe than a large tractor and disk.

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OBJECTIVE

The objectives of this study and demonstrations are to apply what we have learned about tillage and soil compaction in field crops for small gardens and small-scale vegetable producers and to demonstrate the effects of soil compaction and techniques to overcome its negative effects on root growth..

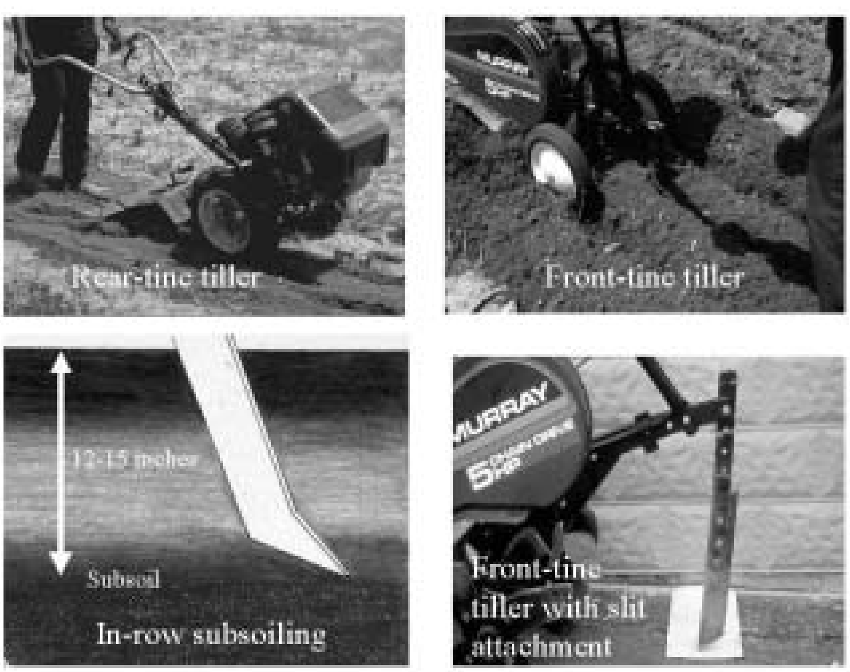
METHODS

Since the early 1990s, experiments and demonstrations with Master Gardeners have demonstrated the effect of soil compaction on selected vegetable crops using common and modified mechanical garden tillage techniques. These tests and demonstrations have enabled us to explain soil compaction to Alabama gardeners and small-scale vegetable producers.

Auburn Experiment

One of the first experiments was located on the campus of Auburn University on a Marvyn loamy sand (fine-loamy, siliceous, thermic Typic Kanhapludults), a typically sandy, Coastal Plain soil with a sandy clay loam subsoil (Bt horizon) approximately 10-12 inches deep. These soils are known to develop traffic pans about 8 inches deep. Soil was limed as needed to†maintain soil pH between 5.8 and 6.5. Phosphorus, potassium, and sulfur were applied annually at a rate of 100, 100, and 20 pounds per acre P_2O_5, K_2O, and sulfate-S, respectively. Nitrogen was applied to sweet corn at 150 pounds N per acre in split applications and to okra at 80 pounds N per acre in split applications.

Fig.1. Treatments used in the Auburn experiment.



Soil was prepared just prior to spring planting using four tillage treatments (Fig. 1):

(1) Rear-tine garden tiller Using a 10-hp rear-tine, BCS garden tiller; soil was prepared to a depth of 6 inches with multiple passes of tiller just prior to planting.

(2) Front-tine garden tiller Using a 5 hp front tine garden tiller; soil was prepared with multiple passes of tiller just prior to planting; tillage depth was approximately 6 inches.

(3) In-row subsoiled Using a small tractor and a conventional subsoil shank to a depth of 14 inches directly beneath the row. Final seedbed preparation was made with the rear-tined tiller as in treatment 3 to a depth of 4 inches.

(4) Slit tillage Using the same 5 hp, front-tined, garden tiller adapted with a modified drag bar to cut a slit 12 inches beneath the row; soil was prepared as in the above treatment as the slit was being cut directly beneath the row.

Crops planted during the 3-year experiment were:

- Sweet corn (*Zea mays L*. var. silver queen) — every year
- Okra (*Abelmoschus esculentus (L.) Moench* var. Clemson spineless) — 2 of 3 years
- Southern peas (*Vigna unguiculata (L.) Walp* var. Pinkeye Purplehull) — 1 of 3 years

Each crop was planted in a separate, randomized block with four replications. During the third year of the experiment, seedling disease resulted in such a poor stand of okra that the plots were replanted in southern peas. All plots consisted of three, 36-inch rows 15 to 20 feet long. Marketable yield was measured by harvesting the center row in each plot. Sweet corn was picked twice. Okra was picked twice weekly for a total of 15 to 20 harvests. Southern peas were harvested twice as mature, green pods.

Soil penetrometer measurements were taken in early fall of year 1 and year 3 to determine relative compaction of the soil.

Cullman Experiment

The Cullman County Master Gardeners have assisted in conducting a similar experiment with additional tillage variables at the North Alabama

Fig. 2. Additional treatments used in the Cullman experiment and in the Central Alabama demonstration.

Horticulture Substation at Cullman, Alabama, in 2001 and 2002. The soil at this site is mapped as a Hartsells fine sandy loam (fine-loamy, siliceous, thermic Typic Hapludults). Eight treatments were used with the first four treatments being the same as described in the previous experiment (Fig. 1, 2):

1. Front-tine garden tiller.
2. Slit tillage.
3. Rear-tine garden tiller. (8-hp Troy Bilt was used).
4. In-row subsoiled.
5. Hand tilled using the "double-digging" technique under the row.
6. No tillage using a spade or blade to cut a slit into subsoil.
7. Conventional disking with a small tractor
8. Rototilling using tractor-mounted rototiller.

Sweet corn was planted on this site in mid April and harvested in late July. Plot size was 12 feet by 20 feet (4, 36-inch rows 20 feet long) and treatments were replicated four times in randomized blocks. The two center rows were harvested for yield. Following sweet corn harvest, the stalks were cut and cabbage and broccoli were hand planted as a fall crop with no additional tillage. This experiment will be repeated at Cullman.

Central Alabama demonstration

The same experiment conducted at Cullman is also being repeated as a non-replicated demonstration at E.V. Smith Research Center in Central Alabama on a Norfolk fine sandy loam (fine-loamy, siliceous, thermic Typic Kandiudults) in 2002. Alabama Master Gardeners are helping to conduct this demonstration.

RESULTS

Experiment 1

In some years, crops under moisture stress showed dramatic, visual, growth responses to the 4 tillage practices. The degree of stress, of course was dependent on soil moisture. Total marketable yields reflect rainfall distribution as well as tillage practice. None of the crops were irrigated. †There were significant and fairly consistent yield differences due to tillage for every crop and every year of the test. Slit tillage increased total marketable yield of sweet corn, okra, and southern peas (Fig. 3, 4, 5). The rear-

Fig. 3. Three-year average marketable yields of sweet corn as affected by the type of tillage system used in the Auburn experiment. Yields followed by the same letter are not significantly different ($P = 0.05$).

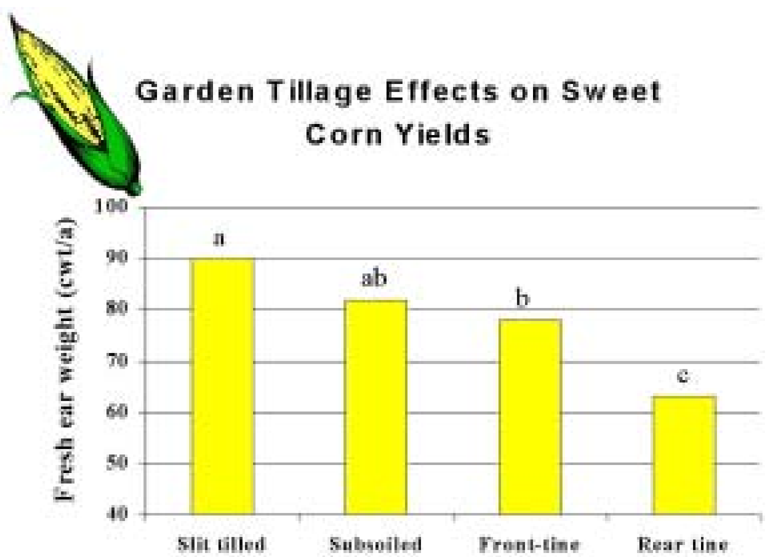


Fig. 4. Two-yr average marketable yields of okra as affected by the type of tillage system used in the Auburn experiment. Yields followed by the same letter are not significantly different ($P = 0.05$).

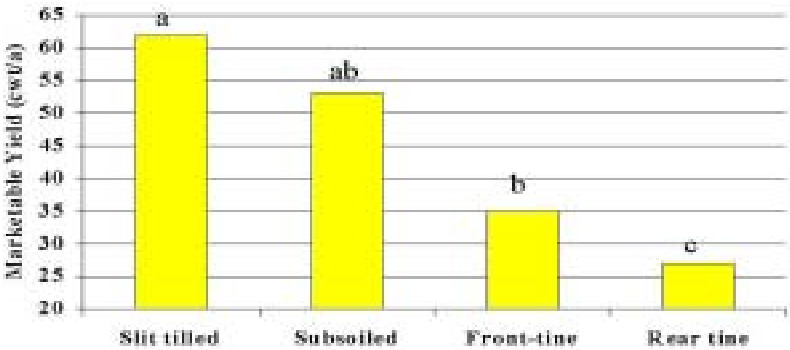


Fig. 5. Average marketable yields of southern peas as affected by the type of tillage system used in the Auburn experiment. Yields followed by the same letter are not significantly different (P<0.05) from others.

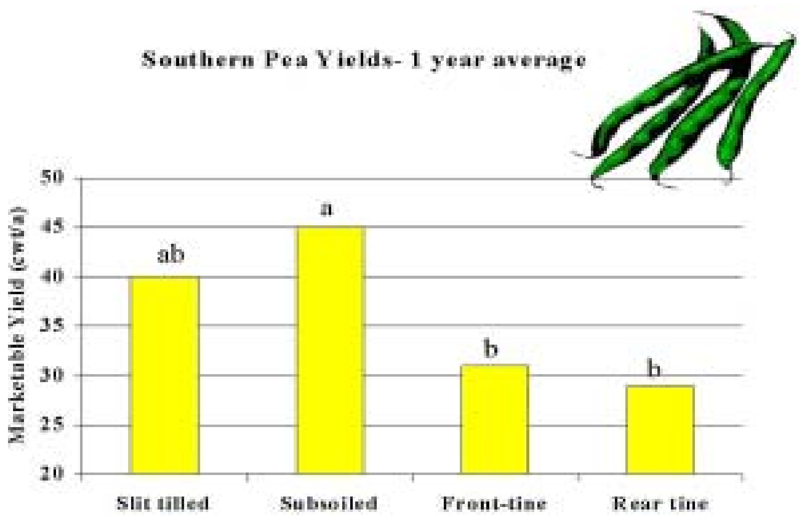
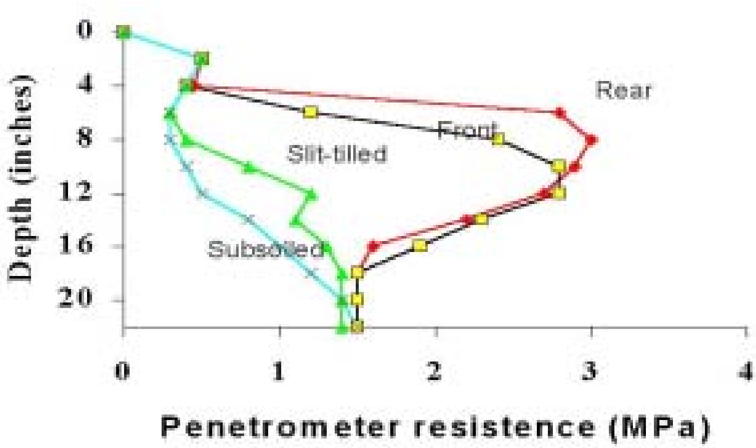


Fig. 6. Average penetrometer resistance (relative soil compaction) taken under the row after the first and third growing seasons following sweet corn and southern peas.



tined tiller resulted in lowest yield, presumably due to soil compaction resulting in moisture stress during short-term droughts. In general, yields were of the order:

Subsoiled = Slit tilled > Front-tine tiller > Rear-tine tiller

Soil penetrometer measurements made in the row at the end of the cropping. Season identified pronounced soil compaction following the rear-tine. Tiller and the front-tine tiller (Fig. 6). Subsoiling and slit tillage effectively disrupted the plow sole at 20-30 cm.

Experiment 2

An extremely wet summer and severe summer thunderstorms damaged the corn crop. We also believe that the very wet season reduced the expected responses to the tillage variables. Problems with weeds and cutworms masked any tillage variables we may have had in the fall crop. No data are presented.

SUMMARY

Slit tillage using a modified 5-hp garden tiller in a sandy Coastal Plain soil significantly increased yields of sweet corn, okra, and southern peas over more conventional tillage practices such as using a standard, front-tined or rear-tined garden tiller. Slit tillage disrupted traffic pans, reduced in-row soil compaction, and resulted in yields as high or higher than traditional subsoiling. Slit tillage may offer the home gardener and small farmer a low-cost solution to a soil compaction problem created by conventional tillage practices. Additional techniques such as double digging and manual slits using a spade are being evaluated for use by the home gardener in reducing the damaging effects of subsoil compaction.