

## AUTOMATIC TRANSPLANTER FOR VEGETABLES

LAWRANCE N. SHAW  
*LandTechnic, Inc.*  
8715 N.W. 4th Place  
Gainesville, FL 32607

**Abstract.** A fully automatic field transplanting machine has been developed for vegetables. This machine will receive trays of seedlings, individually remove the plants, and set them into the soil without manual handling. This machine will accommodate several popular greenhouse growing trays including the 288, 242, and 240 cell trays. The cup type transplanter will set plants through plastic mulch as well as in bare ground at a rate of 7000 plants per hour per row unit or nearly one acre per hour of Florida tomatoes.

### Introduction

The establishment of vegetable crops by transplanting is increasing because expensive seed can be better utilized, the field growing season is shorter so less irrigation is required, crops can be harvested earlier, and the crop is more uniform because seedling emergence is usually better in a greenhouse as compared to a field environment. The introduction of modular tray seedling production about 30 years ago (Todd, 1972), has increased the quality of seedlings over the bare root type and has made handling of the seedlings easier since 200 to 300 plants can be handled in each tray. The greenhouse production of these seedlings is quite modern with a minimum amount of labor required for seeding the trays, watering them, and growing them to a transplant stage. However, the setting of the seedlings into field soil is still a very labor intensive operation. Each field worker is only able to set 3000 to 4000 seedlings per hour (Boa, 1984), so a considerable labor force is required at transplanting time. The introduction of the modular seedlings in greenhouse trays makes it possible to produce good quality uniform seedlings in an orderly array that could possibly be set in the field by machine. A machine has been now developed especially for Florida vegetable production that can transplant over 7000 seedlings per hour per row unit from any of several popular greenhouse production trays and it can transplant into plastic mulch covered beds. The plant spacing in the row is adjustable to suit several different crops.

### Materials and Methods

The automatic transplanter (Fig. 1) consists of two major components: a plant removal mechanism and a plant setting mechanism, and these components will be discussed in order.

*Development of the Plant Removal Mechanism:* This device must remove individual seedling plants from a greenhouse tray and deliver them to the plant setting mechanism. The plant removal mechanism (Shaw, 1997) receives the greenhouse trays in a vertical orientation with the plants horizontal. The seedlings are sequentially ejected from the tray cells of

each row and the trays are advanced downward as each row is emptied. The seedling plants are removed by pneumatically operated ejectors acting through the cell drain holes and each plant falls between flights of a horizontal conveyor which delivers them to the plant setting mechanism.

Air jets on the end of each ejector can be used if needed to assist in the loosening of the seedling roots from the cells and have effectively increased plant removal. With many seedlings there is interference from the seedlings in the row above the row being emptied so a moving plant divider has been developed that lifts the foliage of the seedlings above each plant as it is removed and this reduces the tangling of foliage between the seedlings. This device has been especially effective on tomato seedlings. The tray advance mechanism is so designed that it takes a big step between the last row of cells in a tray and the first row of cells in the following tray. As the seedling trays are emptied they progress downward on the vertical tray holder and drop out under the machine for later retrieval.

*Development of the Plant Setting Mechanism:* For high speed operation, a mechanism was needed that would effectively place each individual plant into the soil as the machine moves along. A spatial kinematic mechanism (Shaw, 1988) was developed that receives a horizontal seedling from the plant supply mechanism conveyor and turns it to an erect position before inserting it into a dibbled hole in the soil. The individual plants or seedlings are transported in cups from the loading position of the plant setting mechanism to the point where they are inserted into the ground. The plants are discharged from the cups through the pointed end of each cup which also dibbles the planting hole in the soil. The motion of each cup on the mechanism is such that the rearward velocity of each cup relative to the machine matches the forward machine velocity so that each plant is set in a stationary position in the soil. This velocity relationship between the machine and the soil allows high speed operation and is maintained at various travel speeds because the machine is driven from a ground wheel.

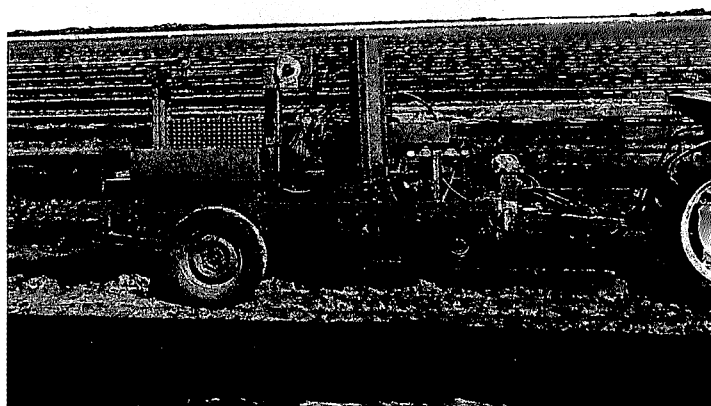


Figure 1. Transplanting tomatoes through plastic mulch.

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The in-row spacing of the seedling plants can be adjusted by changing the distance between and the number of cups on the plant setting mechanism. The transplanting depth can be adjusted by use of the hydraulic lift on the machine wheels. Two pneumatic press wheels are used to firm the soil around the seedlings after they are set into the soil.

When planting through plastic mulch, the pointed end of each cup can be used to pierce holes in the film or a "hole burner" (Shaw, 1996) can be attached ahead of the plant setting mechanism to melt holes for the seedling plants. The hole burner and the plant setting mechanism are coordinated so that the seedlings are precisely planted in the holes in the mulch.

## Results and Discussion

The automatic transplanting machine has been used to transplant both tomato and pepper seedlings into bare ground and through plastic mulch. The transplanting rate is regularly over 7000 plants per hour per row unit. The machine has transplanted seedlings from six different conventional greenhouse growing trays and these include the Plantway (Plantway Ltd., North Road, Great Abington, Cambridge shire CB1 6AS, U.K.) 240 cell thermoplastic tray, three different versions of the Speedling (Speedling Inc., P.O. Box 7220, Sun City, FL 33586-7220) 288 cell expanded polystyrene tray, and Speedling and Plants of Ruskin (Plants of Ruskin, Inc., 901 - 4th St. N.W., Ruskin, FL 33570) 242 cell expanded polystyrene trays. The machine can be adapted to other trays that have a rectangular cell pattern and a minimum drain hole diameter of 0.22 inch (5.6 mm).

On a regular basis the machine will transplant over 98% of good quality seedlings from a tray and regularly removes all of the seedlings from the trays. This machine was designed for 7 to 8 inch (180 to 200 mm) total length seedlings and some

difficulty has been experienced with plants over 9 to 10 inches (230 to 250 mm) in length, but future designs of the machine will accommodate larger plants.

If plants have developed past the ideal transplanting stage there may be root growth between the cells and into the polystyrene tray material; both of these problems make plant removal difficult and can cause seedlings to be strung together or to be left in the tray. The air jet ejectors help overcome the second problem.

This transplanting machine does not compensate for blank cells in the trays, but it is anticipated that trays that will be automatically transplanted will be filled in at the greenhouse before they are transported to the field. In this way, there will not be an excessive number of blank spaces which will have to be filled in by field workers following the machine.

Since this transplanter can empty a typical tray every two and a half minutes, a single machine operator could tend up to four row units. With four transplanter units mounted on a tractor, two workers should be able to do the work of the nine workers required to feed four manual transplanters and drive a tractor. It is anticipated that machines of this type will be able to take over the tedious task of transplanting vegetable crops and increase the efficiency of vegetable production in Florida.

## Literature Cited

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