DOUBLE CROPPING TOMATO BEDS WITH THE REVOLVING SPADE PLANTER

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Abstract. Because there is usually residual fertilizer under the polyethylene mulch after a crop of tomatoes (Lycopersicon esculentum Mill.) is harvested, some Florida growers have been interested in utilizing these plant nutrients for a second crop of beans (Phaseolus vulgaris L.), sweet corn (Zea mays L. var rugosa Bonaf.) or watermelons ([Citrullus lanatus (Thumb.) Matsum. + Nakai.]). The planting machines suitable for seeding these second crops are quite expensive and troublesome due to their complexity. Recently, however, the revolving spade planter has been used to plant beans in tomato beds on rock soil in Dade County, and the crop emergence has been about 95 percent. Cost of planting was approximately $20 per acre as compared to $100 per acre for hand planting.

Introduction

Producing a second vegetable crop on polyethylene-mulched tomato beds can be justified both environmentally and economically. For many years, vegetable growers have been interested in utilizing residual fertilizer, after the initial crop on polyethylene mulch has been harvested, by planting a second crop and thus minimizing the potential of this fertilizer to cause ground water pollution. Generally, only one crop of tomatoes is grown on the polyethylene-mulched beds, but many growers would like to plant squash, watermelons, beans, or sweet corn as a second crop to utilize the residual fertilizer, if a means of establishing these crops were feasible. This need for second cropping on polyethylene-covered beds led to the development of a punch planter (Shaw et al. 1978) by the Agricultural Engineering Department at the University of Florida. For second cropping the planter must not dislodge the polyethylene or shift the film so that it covers the planting holes. This first punch planter developed by the University performed satisfactorily and was copied by several European manufacturers, but, because it had many moving parts and it was difficult to lubricate, a great deal of maintenance was required.

Interest in second cropping continued in Florida and planter development for crops grown on polyethylene mulch was given a high priority. Cooperative work was initiated between the University of Florida and the Institut fur Landtechnic at the University of Bonn in Germany (Shaw et al., 1987) because the European farmers are increasing their use of polyethylene mulch.

A principal objective of the redesign of the punch planter was to eliminate any moving parts that would come in contact with the soil. Although several punch and seed delivery concepts were considered, the one selected incorporated hollow spades radially mounted on a wheel, which formed cavities in the soil to receive seeds. The cavities could be formed while turning the wheel with positive or negative slip or by slightly yawing the wheel relative to the direction of travel; this last method was selected for simplicity. The transverse shifting of each lug as the wheel turns forms a cavity shaped like the end of a very thin ellipse. As each spade enters the soil, it pushes the soil to one side, forming a cavity for the deposition of the seed. Although this displaced soil is compacted on one side of each cavity, there is minimal compaction on the remaining surfaces.

With this variation in compaction, there is the opportunity for good soil to seed contact and thus good capillary action. The wheel axis was also inclined from the horizontal to allow easier entry of the spades into the soil and to allow the mounting of a seed metering device as close to the hollow spades as possible. After the seed is deposited and each spade withdrawn, the soil is pushed back into each cavity with an inclined press wheel. On this revolving spade planter, built in Germany in 1986, a hopper (kleine-Maxicorn) with an inclined cell wheel was incorporated. This hopper was driven directly from the hub of the spade wheel through a coupling.

Revolving Spade Planter — Redesigned

After the cooperative work done in 1986, development of the revolving spade planter was continued in the Agricultural Engineering Department at the University of Florida. Changes from the original design included a redesigned spade wheel and a vacuum seed-metering device with a suction fan. Because the original cell wheel seed-meter was not readily available in the United States, it was decided to use a vacuum seed-metering device. And since it was anticipated that crops with medium to large seeds would generally be planted with this machine, a vacuum seed-meter (John Deere Maxemerge 2) was selected. Because the new seed-metering device required a vacuum source, an electrically powered suction fan, powered from a generator set, was assembled with the planter unit. The seed-metering device was positioned near the seed entry point on the spades to facilitate the delivery of the seed to each spade.

The new spade wheel was designed with 15 spades and with a spade spacing of 10 inches. The spade wheel was mounted on a chassis with an adjustable yaw angle, and the unit was designed for tractor tool-bar mounting. An adjustable press wheel was added to regulate the depth of
the cavity and to push the soil around the seeds after they were deposited in the earth.

The redesigned spade wheel planter was extensively tested in the laboratory to optimize the synchronization of the seed drop into the spades, and then it was field tested, planting corn and soybeans in sandy soil. The uniformity of spacing and planting depth was found to be equal or superior to that of most planters used with vegetable crops (Debicki 1990).

**Commercial Use of the Revolving Spade Planter**

After the disastrous Dec. 1989 freeze, a tomato grower near Homestead, Florida, expressed an interest in evaluating this spade planter for planting stick beans on staked tomato beds on rockdale soil. Planting a second crop on these beds presented some problems because steel tomato stakes were used with this crop and there was only a 72-inch row spacing for the tractor and planter. The spade planter was mounted on a narrow tool bar attached to a small tractor, and then the planter spade wheel was positioned so that it would plant within 6 inches of the steel stakes (Fig. 1). A steering guide was mounted on the front of the tractor to assist the operator in driving precisely between the adjacent rows of stakes. Operating the planter at a field speed of 2 to 3 mph resulted in quite uniform planting. The speed was limited only by the ability of the operator to drive between the rows of steel stakes.

Because the hopper had been designed for smaller seeds than those of the stick beans, a problem developed with the flow of the seeds from the hopper to the metering plate. To eliminate the problem, the hopper was enlarged and repositioned, and a more powerful vacuum source, capable of developing a suction of 75 to 80 inches of water, was installed to hold the large bean seeds to the seed-meter plate. Because a suitable plate for stick bean seeds was not available from the seed meter manufacturer, the planter was tested with a metering plate adapted by the grower to accept the large bean seeds. After some adjustments in the size and shape of the seed cells, amount of vacuum required, size of the vacuum orifice, and timing between the seed meter and the spades, the delivery of the seeds to the ground was satisfactory.

The planting objective was to place at least 1 seed in each punched hole. Holes were easily punched through the polyethylene mulch without any shifting of the film.
over the cavities in the soil. And there were no problems with the yawed wheel pulling the film loose from the ground. Seeds were deposited in the formed cavities at approximately 1 inch deep. The press wheel was able to push some soil in over the seed, but exposed seeds did not seem to present problems with seed emergence and survival. There was plant emergence from 95% of the punched holes (Fig. 2).

Discussion

The spade planter performed quite satisfactorily on the polyethylene mulch and the rocky soil. There were no problems with the planter operating in decaying fruit and other plant material as there had been with the original punch planter. The performance of this spade planter was superior to that of the earlier planter, and because it is a simpler machine, it should be more economical to manufacture and easier to maintain.

The planter delivered the seeds accurately to the planting cavities, and the emergence rate was approximately 95%.

Cost of planting with the spade planter was approximately $20/per acre as compared to $100/per acre for hand planting, which was the only alternative at the time.

With this revolving spade planter, a vegetable grower can second crop his tomato fields with another vegetable crop at a reasonable cost as well as reduce a water pollution problem.

POTATO YIELD AND SOFT-ROT POTENTIAL AS INFLUENCED BY CALCIUM AND POTASSIUM FERTILIZATION

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Additional index words. Solanum tuberosum, Erwinia carotovora.

Abstract. Effects of Ca and K rate, Ca placement, and cultivar on tuber yield, tissue Ca and K concentrations, and tuber softrot potential (Erwinia carotovora) were evaluated on potatoes (Solanum tuberosum L.) grown during 3 seasons on an Ellzey fine sand soil. Application of Ca at 0, 450 and 900 kg-ha⁻¹ from gypsum increased soil Ca in each season, potato tissue Ca in some seasons, and tuber yields in 1 of 3 seasons. Tuber specific gravity was not affected by Ca rate. Tissue K concentrations were increased in 2 of 3 seasons with an increase in K rate from 225 to 450 kg-ha⁻¹. Yields were not affected by K rate, but specific gravities of tubers were lower in 2 of 3 seasons with an increase in K rate. Tuber yields and specific gravities were higher with ‘La Chipper’ and ‘Atlantic’ than with ‘Superior’. With freshly harvested tubers, soft rot severities varied in each year of the study and averaged 49, 11, and 4% over all treatments in 1984, 1985, and 1986, respectively.

These values related to total rainfall received on the crop, e.g., 37, 18, and 13 cm, respectively. Effects of Ca rate and cultivar on disease severity were variable. Severity was affected by interactions involving Ca rate and cultivar. Soft-rot was generally higher with the higher K rate.

Introduction

Potatoes are grown extensively in Florida on coarse-textured soils that are moderate to low in extractable Ca (400 to 800 ppm Ca). Low tuber Ca concentrations have been associated with low yields, poor tuber quality (Simmons and Kelling, 1988) and with an increase in tuber susceptibility to bacterial soft rot and internal brown spot (McGuire and Kelman, 1984 and Tzeng et al., 1986). In Wisconsin, application of Ca on coarse-textured soils that contain more than 350 ppm Ca have provided inconsistent yield responses (Simmons and Kelling, 1988).

Tuber Ca concentration is influenced by a number of factors including placement of Ca (Kratzke and Palta, 1986 and Simmons et al., 1988), soil type (Simmons and Kelling, 1988), competition of other cations, particularly K and NH₄ (Bangerth, 1979 and Rhue et al., 1986), method of irrigation, rainfall, and cultivar. Placement of Ca in the tuberization area increases tuber Ca more than placement in the basal root region (Kratzke and Palta, 1986). Ca-related tuber disorders are far more common than Ca deficient petiole tissue (Bangerth, 1979).

Maximum tuber yield can be obtained in northeast Florida with 168 kg K ha⁻¹ even on a soil considered low in K (Rhue et al., 1986). However, many producers apply 2 to 3 times this K amount. Thus, with lower soil Ca and poor Ca placement, an excessive application of K may induce a deficiency of Ca.

Studies reported here were conducted to determine the effects of Ca rate, Ca placement, K rate and cultivar on...