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Influence of Tillage, Nitrogen, and Rye Cover Crop on Growth and Yield of Tomatoes[1]

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Abstract. **Field studies were conducted on an Orangeburg sandy loam soil (Typic Paleudults) in central Alabama to determine the effects of tillage methods (complete, strip, and no-tillage), nitrogen rates (100 and 200 kg/ha), and rye (*Secale cereale*) cover crop on growth and yield of tomatoes (*Lycopersicon esculentum* Mill.). Marketable tomato yields tended to decrease as amount of tillage decreased. The 3-year average yields for complete-tillage, strip-tillage, and no-tillage treatments were 29.9, 27.0, and 26.0 MT/ha, respectively. There was no consistent effect from N-rate on marketable yields. Average yields from the lower N-rate were greater than the higher N-rate in the two driest years and were similar or higher from the higher N-rate in the year of more average rainfall. Marketable yields tended to be greater on no-rye plots than on rye plots, with yields averaging 2.2 MT/ha higher for no-rye plots.**

Interest in conservation tillage as a means of conserving energy, labor, soil, and water has increased considerably in recent years. Conservation tillage systems may affect crop yields by their effects on soil temperature, water relationships, mineralization of crop residue, insects, diseases, weeds, soil compaction, and fertilizer requirement. Reduced tillage systems have been developed for several agronomic crops (4, 6), but there has been little work with reduced tillage on vegetable crops such as tomatoes. Beste (1) found that yields of seeded tomatoes grown in a no-tillage system were equal to those grown with conventional tillage. No-tillage systems for vegetable crops should allow growers to plant and harvest when conditions are too wet for moving equipment under conventional tillage methods. When adequate planting equipment is developed and satisfactory herbicide applications for weed control and sod-killing are determined, no-tillage production of some vegetable crops may be as successful as that of corn and soybeans (3, 5).

Higher yields with no tillage are often associated with greater availability and more efficient use of soil water. Blevins et al. (2) reported that soil moisture was enhanced by increased water infiltration and by reduction of evaporation loss with no-tillage systems.

Since little or no incorporation of fertilizer and crop residue is possible with no-tillage cropping, nutrient distribution and availability may be affected by these management systems. Stanford et al. (7) suggested that fertility-tillage interactions may be an important source of yield variability.

The purpose of this experiment was to determine the effects of different tillage methods, N-rates, and a rye cover crop on growth and yield of tomatoes.

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[3]This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended.

Materials and Methods

'Tropic' tomatoes were field-grown in central Alabama with different tillage methods, N-rates, and rye cover crops in 1977, 1978, and 1979, on an Orangeburg sandy loam soil (Typic Paleudults). Treatment variables were tillage (complete, over-row strip 60 cm wide, and no-tillage), N (100 and 200 kg/ha) and rye for winter cover crop (with and without rye cover).

Before any tillage operation, all plots were chiseled to a depth of 40 to 50 cm directly beneath the row. Tillage was with a rotary tiller. A tractor-driven, 203-cm wide rotary tiller was used for complete tillage (conventional), and a 60-cm wide, hand-operated rotary tiller was used for strip tillage. These tillers tilled the upper 20 cm of soil. The no-tillage treatment received only in-row chiseling. Nitrogen from ammonium nitrate was applied at the rate of 56 kg N/ha at planting, and the rest was sidedressed at first fruit set. All plots were fertilized with P and K according to soil test recommendations. Plots received a uniform lime application (2,240 kg/ha) in spring 1979. Rye was seeded each fall but not fertilized. The rye was killed with Paraquat[3] in the spring about 10 days before tillage operations. Dry weights of rye forage samples were taken from an area of 1 m^2 in the center of each plot in the spring each year to determine the amount of rye plant residue on each plot. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of one row 4.6 m long. Row width was 203 cm and plants were spaced 38 cm apart within the row. Six-week-old plants were set in mid-April.

Plants were staked and tied with twine when they were about 45 cm tall and subsequently tied at each 15 cm of growth. They were not pruned. Plants were sprayed weekly throughout the season with insecticide[3] (dimethoate, carbaryl and/or methomyl) and fungicide[3] (zinc ion-maneb complex or chlorothalonil). A herbicide[3] (diphenamid 50 WP at the rate of 13 kg/ha) was applied as a post-plant treatment for weed control. Plant height was measured at first harvest. Fruit was harvested weekly at pink and red-ripe maturity beginning in late June and ending in late July. Marketable yields were graded into 3 size groups: large (5 × 6 – 6.8 cm diameter), medium (6 × 6 – 6.4 to 7.3 cm diameter), and small (6 × 7 – 5.7 to 6.7 cm diameter). Rooting patterns were observed in each treatment after the last harvest each year by excavating for visual observation, but no quantitative data were taken.

Results and Discussion

Early season plant growth each year was greater on no-rye plots than on rye plots. Growth was less in 1977 than in 1978 or 1979. This difference was probably due to low rainfall during the month before planting in 1977. Plant height at first harvest showed no consistent difference due to treatment, but in some cases heights tended to be greater on no-rye than on rye plots (Table 1). Plant heights at first harvest averaged 69, 98, and 109 cm for 1977, 1978, and 1979, respectively. Plant heights at first harvest were significantly correlated ($r = 0.92$) with marketable tomato yields (Fig. 1). This pointed out the need for early growth and development to produce large plants and high yields of marketable tomatoes.

There were significant differences in marketable tomato yields among treatments in all years except 1978 at the 5% level (Table 2) but differences were significant in all 3 years at the 10% level. There was also a difference among years, with average yields being directly related to amount of rainfall received during the growing season. Rainfall during the period from planting to last harvest was below average each year, (14.0, 27.5, and 38.3 cm). This was about 36, 74, and 92% of long-time average for 1977, 1978, and 1979, respectively. Overall average yields for these 3 years were 14.6, 32.3, and 39.4 MT/ha. Marketable tomato yields varied considerably each year, but there was no consistent difference due to treatment. In some cases, yields tended to decrease with reduced tillage. An average for all years shows that marketable yields on complete tillage plots were about 2.9 MT/ha higher than yields from strip-tillage plots, and yields from strip-tillage plots were about 1.0 MT/ha higher than yields from no-tillage plots. Reducing tillage seemed to decrease yields more in 1977 and 1979 than in 1978. An important factor in the lower yields from reduced tillage in 1977 was the dry soil condition at time of planting. With the low rainfall in the early spring before tillage, and the resulting dry soil condition, the chiseling left huge clods or chunks of soil and large voids in the soil profile. These voids permitted further drying of the soil in the no-tillage plots.

Table 1. Average plant height of tomato at first harvest.

Tillage	N rate (kg/ha)	Winter cover crop	Plant height (cm) 1977	1978	1979
Complete	100	none	72ab[z]	106	116
Complete	200	none	74a	102	116
Complete	100	rye	66c	94	106
Complete	200	rye	69bc	92	113
Strip (60 cm)	100	rye	68bc	98	105
Strip (60 cm)	200	rye	69bc	99	110
None	100	rye	68bc	100	104
None	200	rye	65c	96	104
				NS	NS

[z]Mean separation within column by Duncan's multiple range test, 5% level or differences not significant (NS).

Table 2. Marketable tomato yields as affected by tillage, N rate, and winter cover crop.

Tillage	N rate (kg/ha)	Winter cover crop	Marketable tomato yields (MT/ha) 1977	1978	1979
Complete	100	none	19.2a[z]	36.1	43.3ab
Complete	200	none	17.7a	33.4	43.0ab
Complete	100	rye	15.8ab	32.3	39.0abc
Complete	200	rye	15.0abc	31.1	46.2a
Strip (60 cm)	100	rye	11.9bc	32.4	34.0c
Strip (60 cm)	200	rye	15.6ab	31.4	36.4bc
None	100	rye	12.0bc	33.8	36.4bc
None	200	rye	9.3c	27.9	36.6bc

[z]Mean separation within column by Duncan's multiple range test, 5% level.

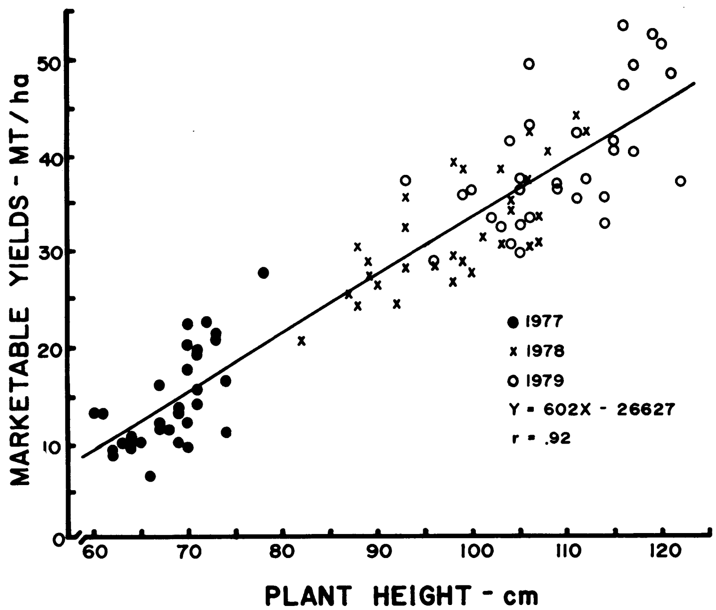

Fig. 1. Relationship of tomato plant height to marketable yields.

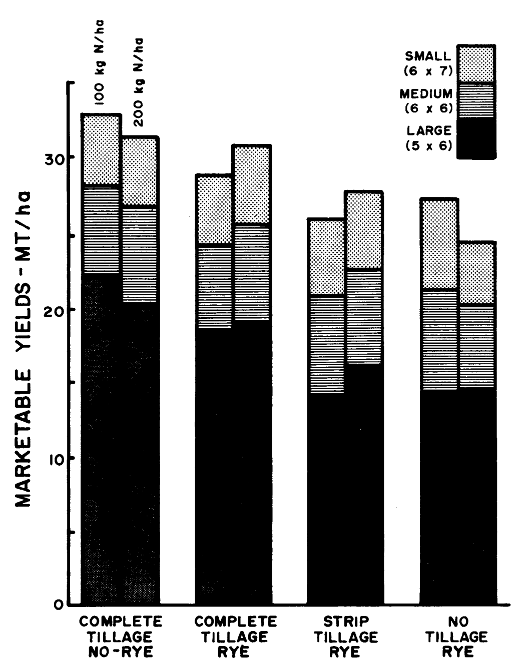

Fig. 2. Marketable tomato yields by fruit size as affected by tillage, N rate, and rye cover crop.

Rototilling on the complete and strip-tillage treatments filled parts of the voids and reduced further drying. The dry soil conditions on reduced tillage plots resulted in slower plant growth and development in early season. Marketable tomato yields were not significantly affected by rye as a winter crop. However, during the 3-year period, yields on no-rye plots averaged 2.2 MT/ha higher than on rye plots. The effect from rye probably resulted from depleted moisture in the soil at planting time. This effect might have been alleviated if the rye had been killed about a month before planting to permit a recharge of soil water from rainfall. Good growth of rye was present each year, with average forage yields ranging from 5.6 to 8.5 MT/ha. Tillage treatments had little effect on rye forage yields. Yields averaged about 1.9 MT/ha greater on high N-rate plots than on low N-rate plots.

The effect of N-rate on marketable tomato yields was not consistent among years (Table 2). Yields tended to be higher on the lower N-rate plots than on the high N-rate plots in 1977 and 1978. In 1979 the yields were similar in about one-half the treatments and favored the high N-rates in the other treatments. It appeared that the low N-rate used was adequate, especially when moisture was more limited.

There was no consistent effect of treatment on the distribution of fruit size (Fig. 2). However, reduced tillage and rye tended to decrease the percentage of large fruit. An average showed that 63% of marketable tomatoes were large on the complete-tillage plots, and 56% were large on strip-tillage and no-tillage plots. An overall average for fruit size distribution showed 61% of marketable tomatoes were large, 22% were medium, and 17% were small.

The amount of cull fruit was not affected by tillage, N-rate, or rye cover crop. An average of all treatments shows that culls made up 36% of total yield. Most cull fruit resulted from catfacing and blossom-end rot.

Observations made at the end of each harvest season showed little effect from treatment on amount or depth of rooting except that there were fewer roots in the 0 to 15-cm soil depth on the no-tillage treatment than on the complete or strip-tillage plots. Roots grew down the chiseled slot and branched out into the subsoil, and all treatments had numerous roots in the soil profile down to about 60 cm.

Summary and Conclusion

Marketable tomato yields tended to decrease with reduced tillage. Yields from complete tillage plots during the 3-year period averaged 2.9 MT/ha higher than yields from strip-tillage plots, and yields from strip-tillage plots were 1.0 MT/ha higher than yields from no-tillage plots. There was no consistent effect from N-rate on marketable tomato yields. Yields from the higher N-rate were greater than yields from the low N-rate in only 1 of 3 years. Marketable tomato yields tended to be higher on no-rye plots than on rye plots for all years. Yields on no-rye plots during the 3-year period averaged 2.2 MT/ha higher than on rye plots. The reduced yields from plots with rye cover crop probably could have been eliminated by killing the vegetation earlier in the spring. This would have allowed more time for the soil profile water to be recharged by rainfall without the offsetting influence of evapotranspiration by a vigorously-growing rye crop.

Literature Cited

1. Beste, C. E. 1973. Evaluation of herbicides in no-till planted cucumbers, tomatoes, and lima beans. N. E. Weed Sci. Soc. Proc. 27:232–239.
2. Blevins, R. L., D. Cook, S. H. Phillips, and R. E. Phillips. 1971. Influence of no-tillage on soil moisture. Agron. J. 63:593–596.
3. Harold, L. L., G. B. Triplett, and W. M. Edwards. 1970. No-tillage corn — characteristics of the system. Agr. Eng. 51:128–131.
4. Jones, J. N., J. E. Moody, G. M. Shear, W. W. Moschler, and J. H. Lillard. 1968. The no-tillage system for corn (*Zea mays* L.) Agron. J. 60:17–30.
5. Morrison, J. E., Jr., D. C. Milbocker, W. O. Atkinson, and J. H. Smiley. 1973. Transplanter modification and survival of transplants under no-till conditions. HortScience 8:483–485.
6. Shear, G. M. and W. W. Moschler. 1969. Continuous corn by the no-tillage and conventional tillage methods: a 6-year comparison. Agron. J. 61:524–526.
7. Stanford, G., O. L. Bennett, and J. L. Power. 1973. Conservation tillage practices and nutrient availability. p. 54–62. In: Conservation tillage. Soil Conservation Society of America, Ankeny, Iowa.