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PERFORMANCE OF VARIABLE RATE NEMATICIDE APPLICATION SYSTEMS

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Abstract

Nematode management relies heavily on the use of nematicides, such as aldicarb (Temik 15G), applied at-planting or preplant soil fumigation with 1,3-dichloropropene (Telone II). Usually growers apply a uniform rate of one of these nematicides across an entire field or even farm. However, nematodes are not uniformly distributed within fields and uniform nematicide applications therefore result in nematicides being applied in areas with and without nematodes infestations. Nematicide applications that are properly matched to spatial distributions of nematodes would be advantageous, reducing environmental contamination, chemical inputs and expenditures. GPS-based equipment for controlling the rates of Telone II and Temik 15G to match the spatial distribution of nematodes were developed and tested under actual field conditions. Tests were conducted during 2002 in a 10-acre field, naturally infested with Columbia lance nematode, to compare efficacy of variable-rate vs. uniform-rate nematicide applications. Both variable-rate applicators closely followed the recommended nematicide application-rate maps. All rates of nematicides increased the cotton yield compared to no-nematicide treatment. The yield increase in the sandy portion of the field was significantly higher than the clay areas. The variable-rate Temik 15G system resulted in 5% higher yield and 34% lower nematicide usage compared to a single rate application. Variable-rate Telone II applications increased lint yield by 5% with a 78% reduction in nematicide usage compared to a single rate application.

Introduction

Plant-parasitic nematodes cause significant yield losses on cotton in most areas of the United States (Blasingame & Patel, 2000). Southern root-knot (*Meloidogyne incognita*) and Columbia lance (*Hoplolaimus columbus*) nematodes are the most important nematodes in South Carolina cotton fields. A recent survey in South Carolina found that the damage threshold for one or both nematode species was exceeded in 63% of the cotton fields (Martin et al. 1994).

Nematode management relies heavily on the use of nematicides, such as aldicarb (Temik 15G), applied at-planting at a cost of $16/acre or preplant soil fumigation with 1,3-dichloropropene (Telone II) at $33/acre. The standard procedure for nematicide use in cotton is to apply a uniform rate of one of these nematicides across an entire field or even farm. However, nematodes are not uniformly distributed within fields and uniform nematicide applications therefore result in nematicides being applied in areas with and without nematodes present.

Soil type and texture have a great effect upon distribution of nematode species and on nematode population densities. In field microplots, reproduction of the root-knot nematode (*M. incognita)* was greater in coarse-textured than in fine-textured soils, and population densities were inversely related to the percentages of silt and clay (Koenning et al., 1996). Our work has shown that soil electrical conductivity correlates strongly to soil texture and distribution of the Columbia lance nematode (Khalilian et al. 2001). This would allow us to predict areas of a field suitable for variable rate application of nematicides. Nematicide applications that are properly matched to spatial distributions of nematodes would be advantageous, reducing environmental contamination, chemical inputs and expenditures.

The objectives of this study were: a) to develop a variable-rate applicator for Telone and Temik; b) to determine the accuracy of the variable-rate application systems; and c) to compare efficacy of variable-rate vs. uniform-rate nematicide application.

Materials and Methods

Equipment

GPS-based equipment for controlling the rates of Telone II and Temik 15G to match the spatial distribution of nematodes were developed. A grower's conventional 4-row Telone injection equipment was modified by adding a variable-rate pump and appropriate electronics to control the pump (Figure 1). A 4-row squeeze-type metering pump, (modified by Chemical Container Corporation, Lakeland, FL) was used to inject Telone II. The pump was driven by a 12V-DC variable speed electric motor (Rae Corporation, McHenry, IL) with rotational speed ranging from 0 to 50 rpm. An onboard computer with Fieldlink software (AGRIS Corporation) and GPS support was used to provide rate information to the controller system. Variable-rate application maps, based on soil electrical conductivity or nematode population densities, are loaded on this computer. A Trimble Ag-GPS–132 receiver with "fast rate" option was used to determine the position of the applicator in the field. This unit contains both OmniSTAR and Beacon differential technology. A Mid-tech rate-controller (TASC-6500, Midwest Technologies, Inc., Springfield, IL) was used to control the speed of the electric motor. Variable-rate Temik 15G was applied using a similar electric motor and controller system as was used for Telone II. Two Micro-band hoppers (Horstine Farmery LTD, England) with a gear-type metering system were attached together with a hex-rod and were driven with the variable-speed motor.

Application Uniformity Test

The applicators for variable-rate-nematicides were evaluated under actual field conditions. The Telone II and Temik 15G systems were calibrated to apply different rates of nematicides. Seven target rates (1, 1.5, 2, 2.5, 3, 3.5 and 4 gal/acre) were selected for the Telone II application uniformity test. A 2-acre field was divided into 200-ft x 12.7-ft grids and a nematicide rate was assigned at random to each grid. A geo-referenced nematicide-rate-map was developed using SSToolbox GIS software and transferred into the FieldLink system. A simple device was developed to collect Telone samples during the field test. A 3-way solenoid valve was inserted at the discharge end of each chemical hose just before the injectors. In normal solenoid mode the system injected Telone II 14-in deep in the crop row. By energizing the solenoid chemical was directed into a collection cup. Samples were collected for 100 ft in each grid and the measured rate of Telone was compared to the target nematicide rate assigned to the same grid. To determine uniformity of application within rows, all four rows were sampled. Each test was repeated four times. A similar procedure was used for the Temik 15G application uniformity test. Six different rates (2, 3, 4, 5, 6 and 7 lbs/acre) were selected for this test and were repeated four time.

Field Test

Tests were conducted during 2002 in a 10-acre field, naturally infested with Columbia lance nematodes, near Elko, SC to compare site-specific, variable-rate nematicide application systems with the conventional uniform-rate method. A commercially available soil-conductivity-measurement system (Veris Technologies 3100) was used to identify variations in soil texture across the field. A soil texture map was developed using GPS and geographic information systems. The soil texture map was used to designate four possible soil types. In each soil type, A minimum of 10 replications of 20-row blocks 50-feet long on 38-inch row centers were established. This large number of replications for each treatment allowed us to make observations on naturally occurring combinations of nematode densities and soil types. Each block was divided into 5, 4-row plots. Each plot was identified using a GPS system so that we could return to identical sites during the growing seasons. The following treatments were applied at random to plots of each block:

1. Uniform rate Temik 15 G (6.0 lbs/acre) applied in-furrow at planting.
2. Variable-rate Temik 15G (3.0 to 7.0 lbs/acre) applied in-furrow at planting.
3. Uniform rate Telone II (3.0 gals/acre) injected 14 in. deep 10 days before planting plus 3 lbs/acre Temik 15G at planting.
4. Variable-rate Telone II (0.0 to 4.0 gals/acre) injected 14 in. deep 10 days before planting plus 3 lbs/acre Temik 15G at planting.
5. Control (no Temik or Telone).

Clemson University's current nematode threshold levels for the Columbia lance nematode were used for variable-rate nematicide application (Table 1). Nematicide application maps were developed and loaded on the onboard computer. The nematicide rate within a single plot was constant and was based on nematode density from the samples taken in November 2001. Cotton (Delta Pine 458 RR) was planted and carried to yield using recommended practices for seeding, fertilization, and insect and weed control. At the initiation of the study, sufficient geo-referenced soil cores were collected to allow nematode assay as well as texture analyses. Nematode samples were also collected at harvest. Yield was recorded using cotton yield monitors mounted on a John Deere picker.

Results and Discussion

Both variable-rate applicators closely followed the recommended nematicide application-rate maps. The results of variable-rate Telone II application uniformity test are given in Figure 2. There was a very good correlation between targeted and measured rates with an average overall error of -2.1% with maximum absolute error of 6.7%. For the Temik 15G system, the measurement errors ranged from -3 to 4.2% with mean error of 1.1 (Figure 3). Also, there was a good correlation between targeted and measured rates. This indicates that it is possible to mach nematicide rate with the spatial distribution of nematodes to reduce chemical inputs and expenditures.

Figure 4 shows the effects of soil electrical conductivity and nematicide application method on lint yields. All of the nematicide treatments increased the cotton yield compared to no-nematicide plots. The yield increase in sandy portion of the field was significantly higher than the clayey areas. This is due to the fact that there were more nematodes in the sandy part of the field.

Variable-rate Temik 15G applications increased lint yields by 5% compared to conventional uniform-rate application. In addition variable-rate Temik system resulted in 34% less nematicide compared to single rate application (Table 2). Similar results were obtained with Telone II system. Variable-rate Telone II resulted in 5% higher yield and 78% lower nematicide usage compared to conventional single rate.

Conclusion

- Both variable-rate applicators closely followed the recommended nematicide-rate maps.
- Measurement errors for the Temik 15G system ranged from -3 to 4.2% with mean error of 1.1%.
- For the Telone II system, the measurement errors ranged from -6.7 to 5.5% with mean error of -2.1%.
- Nematode densities were highly correlated to soil texture as measured by soil EC.
- The nematicide rates needed for adequate control of Columbia lance nematode increased with increasing % sand as predicted by soil EC.
- The variable-rate Temik 15G system resulted in 5% higher yield and 34% lower nematicide usage compared to single rate.
- Variable-rate Telone II increased lint yield by 5% with 78% reduction in nematicide usage compared to single rate.

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Disclaimer

Mention of a trade name does not imply endorsement of the product by Clemson University to the exclusion of others that may be available.

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Table 1. Clemson University's variable-rate nematicide application guidelines.

Columbia lance per 100 ml soil	Telone II (gal/acre)	Temik 15 G (lbs/acre)
Less than 51	0	3
51 to 125	2	5
125 to 200	3	7
more than 200	4	7

Table 2. Effects of variable-rate nematicide application on lint yield and chemical use.

Treatments	Temik 15 G (lbs/acre)	Telone II (gal/acre)	Lint Yield (lbs/acre)
Uniform rate Temik 15 G	6.0	0.0	649 c
Variable-rate Temik 15G	3.9	0.0	687 ab
Uniform rate Telone II	3.0	3.0	663 bc
Variable-rate Telone II	3.0	0.6	696 a
Control	0.0	0.0	566 d

Figure 1. Geo-referenced variable-rate Telone II applicator.

Figure 2. Results of variable-rate Temik 15G application equipment uniformity testes.

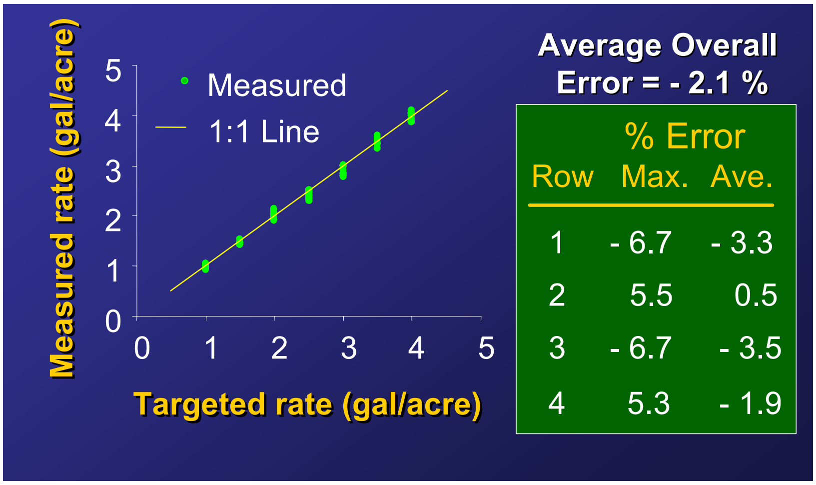

Figure 3. Results of variable-rate Telone II application equipment uniformity testes.

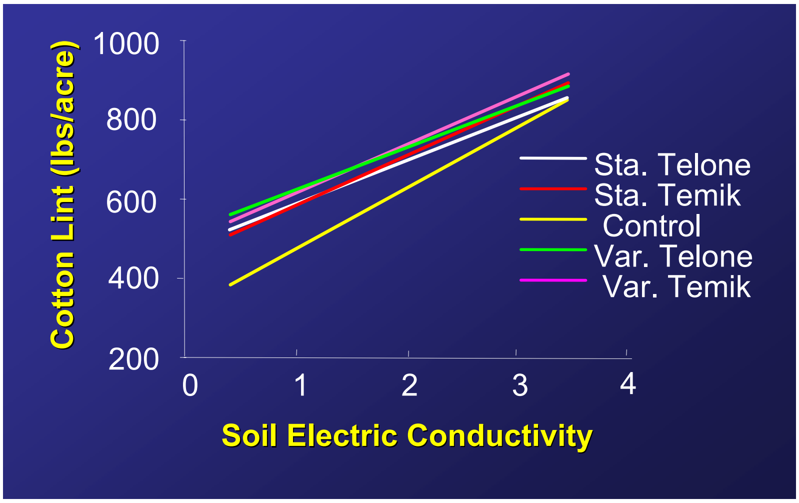

Figure 4. Effects of soil EC and nematicide application method on lint yield.