Nematode Management Simulator

Revised 11/18/10

Outline of the Model

The equation for nematode population growth is based on the logistic equation.

$$N_{t+1} = N_t r \left(\frac{K_t - N_t}{K_t}\right) \quad \text{...Eqn. 1}$$

Where N_{t+1} is the nematode population level at the next time interval, N_t at the current time interval, r is the population increase per individual during a time interval, and K_t is the carrying capacity at the current time.

But K_t is a function of current plant size, so

$$K_t = sP_t \quad \text{...Eqn. 2}$$

Where s is the number of nematodes that can be supported by 1g (or other unit of size) of plant, and P_t is the current plant size.

Then the nematode population equation becomes

$$N_{t+1} = N_t r \left(\frac{sP_t - N_t}{sP_t}\right) \quad \text{...Eqn. 3}$$

And the plant growth equation, recognizing that the effect of the nematode population increases as the number of nematodes approaches the current carrying capacity, becomes

$$P_{t+1} = P_t q \left(\frac{M - P_t}{M}\right)\left(\frac{sP_t - N_t}{sP_t}\right) \quad \text{...Eqn. 4}$$

Where P_{t+1} is the plant size at the next time interval, P_t at the current time interval, q is the growth rate per unit plant size, and M is the maximum plant size.

Then, substitute P_{t+1} and N_{t+1} for P_t and N_t, respectively, and calculate P_{t+2} and N_{t+2} … and so on. In the Simulator spreadsheet, the model is run for 100 days.

The Integrative Regulator

The term $(sP_t - N_t)/sP_t$ is an integrated nematode population/plant size regulator for both the rate of increase of the nematode population and the rate of growth of the plant (see equations 3 and 4).

Management Options

Then we introduce the following management options:

a is the percent reduction in the initial nematode population, N_0; *b* is the percent reduction in the nematode population growth rate, *r*; and *c* is the percent increase in the carrying capacity, *s*. To determine the effects of management, the three model parameters are adjusted as follows:

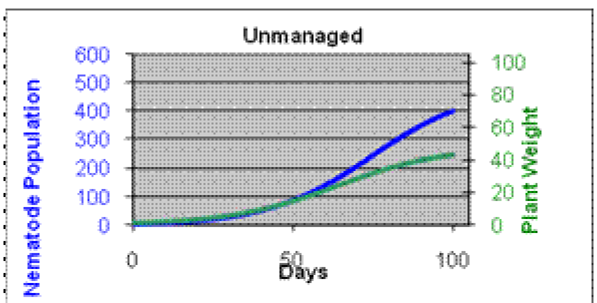
$N_0\left(\frac{100-a}{100}\right)$, $r\left(\frac{100-b}{100}\right)$, and $s\left(\frac{100+c}{100}\right)$.

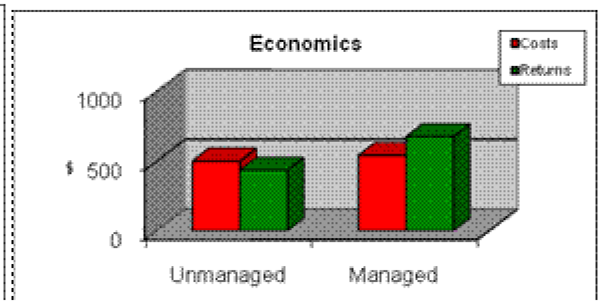
Now we can test the effects of altering the three management options (see examples below).

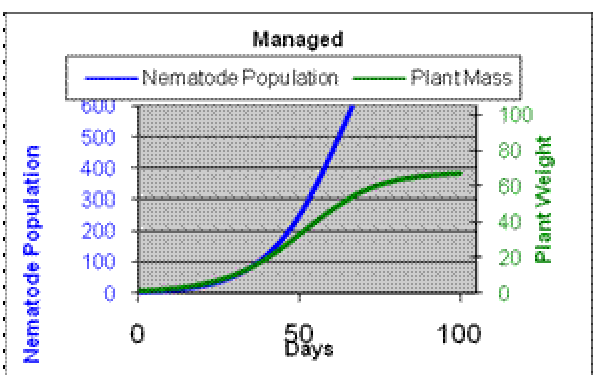
What is the best management strategy or combination of strategies? Use the [Management Strategy Simulator]() (the above model) in Nemaplex.

Some Examples

1. **Decrease initial nematode population by 80% (i.e., *a*=80) at a cost of $120.**

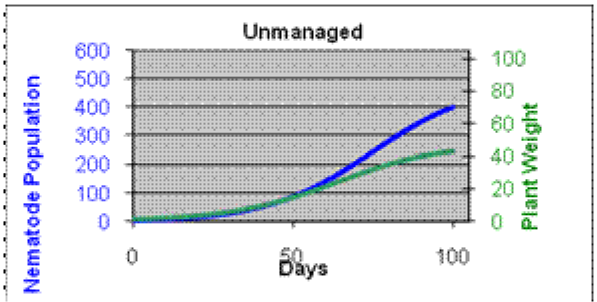


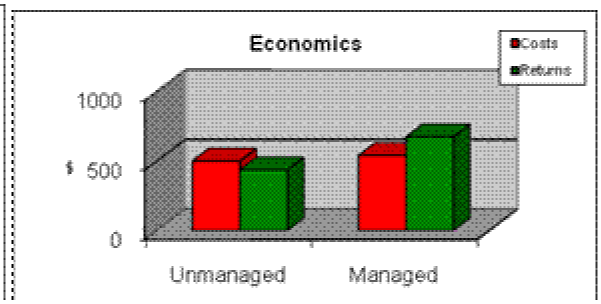


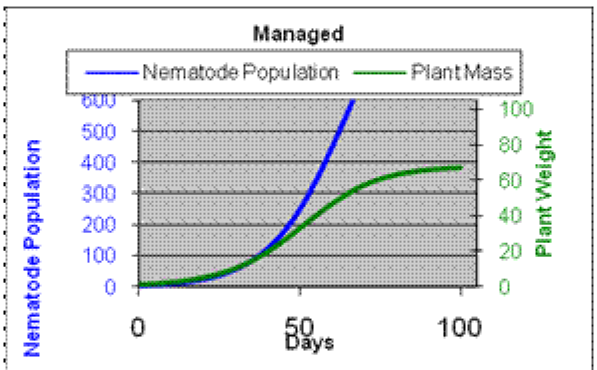


In the managed situation, the plant grows well initially and has a higher final yield than the unmanaged. However, since the managed initial population is lower relative to the carrying capacity, it grows at a faster rate and the final population is very large. That may create an enormous problem for next year.

2. Decrease nematode growth rate by 50% (i.e., *b*=50) at a cost of $85 (but how will you do this?).

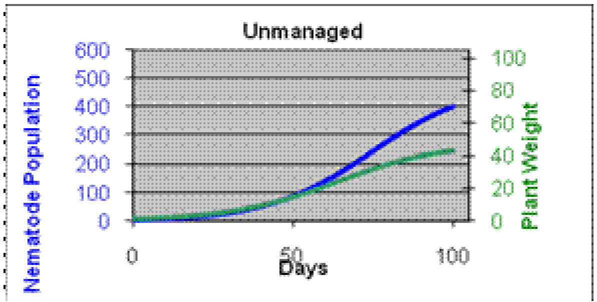


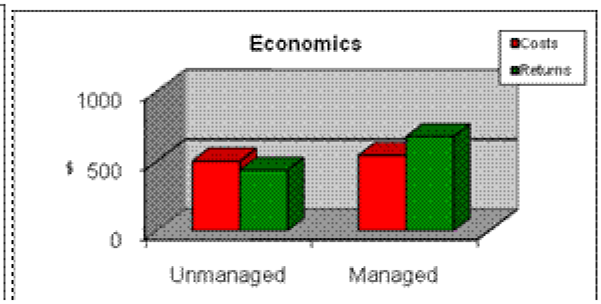


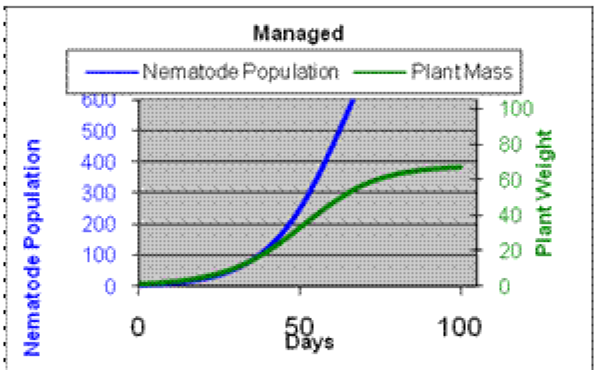


In the managed situation, the plant grows well throughout and almost achieves maximum final yield because the nematode pressure is lower throughout the growth period. Also, because the population growth rate is lower, the final population is lower than in the first example. The problem for next year is less than that in the first example.

3. Increase carrying capacity for the nematode by 60% (i.e., *c*=60) at a cost of $40 (but how will you do this?).







The plant grows a little better than the unmanaged, but the final nematode population is enormous – a problem for next year.