Model of the Use of Multi-lines for Disease Control

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Objective: To see the epidemiological effect of the use of multi-lines to control disease.

Background:
One of the arguments for the use of multi-lines of cultivars (which are similar to one another from an agronomic standpoint, but which each have resistance to different races or strains of pathogens) is that disease control is greater than if using single cultivars (even one with resistance genes to multiple strains.) The reason for this is primarily an effect of the reduced capacity of pathogens to spread if they cannot establish infections in resistant plants, and is also an effect from the initiation of SAR (Systemic Acquired Resistance.) We wanted to examine the effect of multi-lines under a simple, optimal scenario to determine their effect on plant disease epidemics.

How to Play:

*Please keep in mind: The concepts of the game are simple, but there is a lot of “book-keeping” to keep track of. A chart has been provided for you to make things simpler. Make sure to count plants very carefully and add them up correctly at each step on the chart. ☺

*The field is set up as 6 rows, which are each 4 plants wide by 35 plants long. Three of the rows (colored blue) are cultivar “B.” They are resistant to fungal race B. The other three rows are cultivar “A” (colored yellow) which are resistant to fungal race A.

*Each time step consists of a unit of time where both short-distance and long-distance infections are possible. At each point in the game, note in each square which of the two races (A or B) “landed” on the plant, and which time step it is (1, 2, 3...etc.)

*Infections occur only when the plant is not resistant to an isolate. If a race “lands” on a plant (from either short or long distance infection) that has resistance to it, then no infection occurs. Color the plant green to signify an SAR reaction (and note the number of SAR plants in the chart.) SAR plants are resistant to infection by any isolate. They cannot be infected by any race during the rest of the game.

*Incompatible infections (SAR plants) cannot spread, because no true infection occurs, and the pathogen cannot reproduce. No short or long distance movement results from these plants.

*At each time step, (t) short distance movement will infect each of the plants around an existing infection (including diagonally.) They only reproduce themselves, i.e. race A only results in other race A infections. Race B only causes other race B infections.
*At each t, tally the number of each of the two different plant cultivars that have infections. For every 25 infected plants (don’t include SAR plants in this count,) a long distance infection (“jump”) occurs. For example if “B” cultivar has 40 total infected plants, and “A” cultivar has 78 infected plants, then “B” will have 1 long distance infection from isolate A, and “A” cultivar will have 3 long distance infections from isolate B.

*Choose the locations for long distance jumps from the random number table, beginning at your initialization number, and moving down the columns.

*If the two races can each infect one point at the same time period t, choose between them by flipping a coin. “Heads” gives priority to race A, “tails” gives priority to race B.

*The game continues until all of the plants are either infected or SAR plants.