Teacher Notes for Tomato

Compatibility: TI-83+/83+SE/84+/84+SE

Run The Program Called: **TOMATO**

▶ Summary

This program runs simulations of growing tomatoes under different conditions in a greenhouse.

The objective is to identify the optimum conditions for each variety of tomato.

The Background
As a market gardener, you are considering eight options for growing tomatoes in your greenhouses.

- You can grow one of two types of tomato
- You may use additional overnight heating in the greenhouse, or not.
- You may use additional overnight lighting in the greenhouse, or not.

You need to find out which option (or "treatment combination") gives the highest average yield of tomatoes.
In addition, the cost of heating is 2·5 units of yield and the cost of lighting is 2 units of yield, so you are required to find out which treatment combination gives the highest profit in units of yield.
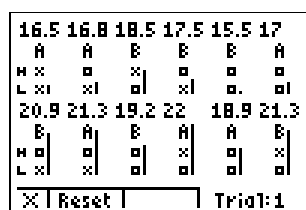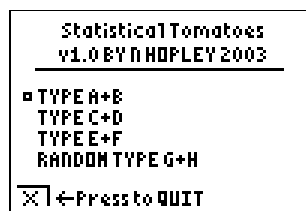
The Experiment
You are going to set aside 1 greenhouse for 2 years for a trial. This greenhouse has 12 compartments - 6 facing North and 6 facing South.
There are no systematic differences between each of the 6 North facing compartments. Likewise for the 6 South facing ones.
All the tomatoes grown in a particular compartment are grown with the same heat and light treatment combination.

▶ Suggestions

1. Run the program **TOMATO**
2. Select whether to compare tomato types A&B, C&D, E&F or G&H

3. On the plan view of the greenhouse, you have 6 North and 6 South compartments, each with their own heating and lighting.
4. Use the **ARROW KEYS** to move the cursor around, pressing either **ZOOM** or **ENTER** to "toggle" the entry in the selected box from one letter to another, or from ON (◻)to OFF(✗), etc
5. When all 12 compartments have been configured as desired, press **WINDOW** to **START** the simulation.
6. The gross yields for each compartment are shown - no account has been made of the cost of heating or lighting in these figures. Against each compartment is drawn a line proportional to its yield, relative to the other compartments (ie longest line = largest yield)
7. Pressing **WINDOW** to **RESET** allows a second year's trial to be

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```
END OF SIMULATION
See your teacher for
the optimum solution


Press any key
```

executed in the same manner
8. After 2 trials, the simulation ends - see the **Further Notes** section for details of passwords to progress with the program.
9. Once the correct password has been entered, the user is presented with the top 6 theoretical mean yields, and their associated profits.

```
LOCKED SIMULATION
Type password to unlock
**
Incorrect Password


Press any key
```

```
Optimum Mean Yields were....
Type A/S H L Yield Profit
 B    S  - L 21.4  19.4
 A    S  - L 21.2  19.2
 B    S  H - 20.4  17.9
 A    S  H - 20.2  17.7
 B    S  H L 19.4  14.9
 A    S  H L 19.2  14.7
      Press any key
```

10. The simulation may be run again at this time - note that for types G & H, the theoretical mean yields are randomly generated and will change each time that the program is run. Types A to F's statistics remain constant.

▶ The Solutions

- It is important that users of the program invest sufficient time in the planning and analysis of results before they have the theoretical mean yields revealed to them.
- The password changes depending on the simulation that was run - where types A & B were tested, the password involves pressing the **MATH** button, then the **APPS** button (these correspond to the letters A and B in green above them). Similarly, the password after testing C & D is **PRGM X⁻¹**, E & F is **SIN COS** and G & H is **TAN ^**
- Should the program become "stuck" in locked mode, then it can be unlocked manually by exiting the program and storing the value of zero into the variable U. (type 0 **STO➔** U)
- All the yields are single samples from Normal distributions with the mean from the tables below and standard deviation 1.

Type A

Heat?	Light?	North	South
-	-	15.2	18.2
Heat	-	17.2	20.2
-	Light	18.2	21.2
Heat	Light	16.2	19.2

Type B

Heat?	Light?	North	South
-	-	15.4	18.4
Heat	-	17.4	20.4
-	Light	18.4	21.4
Heat	Light	16.4	19.4

Characteristics: A & B respond better to light only. Heat and light together have minimal benefit.

Type C

Heat?	Light?	North	South
-	-	18.1	22.1
Heat	-	22.1	26.1
-	Light	20.1	24.1
Heat	Light	23.1	27.1

Type D

Heat?	Light?	North	South
-	-	17.9	21.9
Heat	-	21.9	25.9
-	Light	19.9	23.9
Heat	Light	22.9	26.9

Characteristics: C & D respond well to heat and light, but this is expensive. For cost saving, heat only is the most effective.

Type E

Heat?	Light?	North	South
-	-	22.5	21.5
Heat	-	23.5	22.5
-	Light	25.5	24.5
Heat	Light	24.5	23.5

Type F

Heat?	Light?	North	South
-	-	22.7	21.7
Heat	-	23.7	22.7
-	Light	25.7	24.7
Heat	Light	24.7	23.7

Characteristics: E & F respond better in North facing locations (!) and do well with extra light. Extra heat does not prove worthwhile.

Types G and H are randomly designed each time the program is run, and will exhibit a collection of the above characteristics, and maybe a few more!

▶ Acknowledgements

▶ Student Sheet - Tomato

You are a market gardener and you are considering eight options for growing tomatoes in your greenhouses.

- You can grow one of two types of tomato
- You may use additional overnight heating in the greenhouse, or not.
- You may use additional overnight lighting in the greenhouse, or not.

You need to find out which option (or "treatment combination") gives the highest average yield of tomatoes.

In addition, the <u>cost of heating is 2·5 units of yield</u> and the <u>cost of lighting is 2 units of yield</u>, so you are required to find out which treatment combination gives the highest profit in units of yield.

▶ The Experiment

- You are going to set aside 1 greenhouse for 2 years for a trial. This greenhouse has 12 compartments - 6 facing North and 6 facing South.
- There are no systematic differences between each of the 6 North facing compartments. Likewise for the 6 South facing ones.
- All the tomatoes grown in a particular compartment are grown with the same heat and light treatment combination.

▶ What To Do

1. Run the program **TOMATO**

2. Select whether to compare tomato types A&B, C&D, E&F or G&H

3. On the plan view of the greenhouse, you have 6 North and 6 South compartments, each with their own heating and lighting.

4. Use the **ARROW KEYS** to move the cursor around, pressing either **ZOOM** or **ENTER** to "toggle" the entry in the selected box from one letter to another, or from ON (◼)to OFF(✖), etc

5. When all 12 compartments have been configured as desired, press **WINDOW** to **START** the simulation.

6. The gross yields for each compartment are shown - no account has been made of the cost of heating or lighting in these figures. Against each compartment is drawn a line proportional to its yield, relative to the other compartments (ie longest line = largest yield)

7. Pressing **WINDOW** to **RESET** allows a second year's trial to be executed in the same manner

8. After 2 trials, the simulation ends - see your teacher once you have decided which is the best treatment combination for the tomatoes.