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Phase 1

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Mature Tomato Fruit Growth Model

For this project, the major variables are light and temperature. The variables will be used in order to determine the number of mature fruits per meter squared, the mature fruit weight measured in grams per meter squared, and finally the average mature fruit size in grams of dry weight. The light will be measured by taking the solar radiation levels or daily PAR.

An important concept to understand for this project is how photosynthesis effects the growth of tomatoes. Different light exposure will determine how large a tomato plant will grow and how much fruit it will end up producing. For tomato plants, their ideal light intake is 8 hours of continuous light. In greenhouse conditions shading from the glazing used in greenhouse architecture can affect the type of light allowed into the greenhouse and can induce shading depending on the different covers. This project will determine how having OPV shading different sectors of the grow bed will affect the growth of these tomatoes using calculations derived from previous tomato modeling from different articles.

Different temperatures will also affect plant growth and fruit growth on the tomato plant as the ideal temperature range is between 55 and 75 degrees Fahrenheit. The specific tomato variety being tested is Rebelski. For this specific variety of tomato crop, the ideal night temperature, when fruit is being produced, is between 62 and 66 degrees Fahrenheit, then during the day it should be between 68 and 72 degrees Fahrenheit (Jonny’s Selected Seeds). Temperature is an important input that can be variable as the outside temperature can change drastically which can then affect the internal temperature within a greenhouse. This will be an input since it is not a variable that can be kept constant as easily, and it will then be determined if this given ideal temperature range keeps true depending on the different light inputs to the greenhouse.

Some factors that need to be determined and kept as control values include different environmental and growth factors within the greenhouse. The items listed in this section may not be necessary to the equations needed to determine the different variables that are determined; however, they are important to recognize as they could have a significant affect on the tomato crop growth. These include the CO2 concentrations, the nutrient concentrations for fertigation, humidity within the greenhouse.

For this project, there will be many different equations used in order to model the three variables. They will include other variables that will need to be calculated through experimentation or other models to produce a final program that will calculate all the different growth models to better predict or confirm tomato growth. The next page will explain the further modeling that will take place. It will include different questions that have been found or derived at this current stage.

In order to properly model the number of mature fruits, the plant density should be determined to accurately calculate for all the mature fruit on all the plants. When pruning the fruit, there should be approximately 3 to 4 fruit per truss (Hydro-Gardens). Every fourth node on the plant is a truss and so an equation will need to be derived from the previous tomato model explaining the number of nodes produced per plant (Jones, J. W., “Reduced State”). From that equation a simple formula can be produced: . This equation is just the start and will be further expanded on as the research continues to see if there are any factors other than the previous growth model given.

The mature fruit weight will be denoted as WM and this value has the units of grams per meter squared. This equation when the amount of nodes on the mainstem is greater than the nodes per plant when the fruit appears is added to the coefficient for the development time from first fruit to first ripe fruit. (Jones, J. W., “Reduced State”)

The average mature fruit weight of rebelski tomato variety is 250 grams (Hydro-Gardens). This information can help give an idea of what results should be shown from the code that will be produced. The average weight of the mature fruit will also be determined using different given equations and previous found data. Equations needed to determine the fruit dry matter (WF) is the net aboveground growth rate: . For this equation E is the growth efficiency which is calculated by the ratio of the biomass to photosynthate available for growth. Pg is the gross photosynthesis for the entire day. The variable fR(N) is the fraction partitioning of biomass to roots. This variable will be found by taking data from the other tomato growth model being created. Rm is the daily maintenance respiration which has its own equation. (Jones, J. W., “Reduced State”)

The programming language that will be used is python. The reason for this is to keep the coding consistent within the entire project. This would allow for all the separate codes to be combined to make one larger program where all models can be calculated at once.

The estimated time for this specific model in total will be approximated 25 hours. This is determined one as this project is 25 percent of the grade for each individual. To be more specific, each phase will be broken down into detail to determine how time will be allocated. Phase 1 is the initial research and modeling prep for this program. This entailed finding research articles already showing different growth models for tomatoes that had an input of light and temperature. This research and initial planning phase have taken approximately five hours to complete. Phase 2 of this project seems to be the larger phase where most of the programming and code revisions will be taking place. For this phase it is expected that at minimum ten hours will be needed, but then can be up to approximately fifteen hours. Since this will be a lot of converting existing equations into code it should not take the whole time for the project, however it will take a significant amount as there are many variables that will be involved. Finally, for phase 3 this will be the perfecting of the code; comparing actual data from the experiments occurring at the CEAC greenhouses to determine if the program creates data like that of the actual experiment. This will help rework the code and work out any errors before the final presentation. This phase will take between five and ten hours in order to fully complete.

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The flow chart for the model explained within the report will be attached after the photosynthetic photon flux density in shaded and non-shaded regions. This is because once all the previous values are determined it will then allow for this model to take all of those determined variables, plug them into the given equations and then calculate for any of the three unknown variable regarding fruit weight and number of fruit.

Citations

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