THE APPLICATION OF CLASS CGM MODEL ON THE PEANUT PLANTS (Arachis Hypogaea L.)

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Abstract

The purpose of this research is to learn the working process of CGM model and to compare the water content value of model simulation with field observation. This research was done in the form of experiment. The parameters of the observation were the soil physical observations, they are: the analysis of soil (soil texture), the analysis of bulk density (BV), the measurement of soil water content (KA) every 10 days, and the measurement of the thickness of the soil layer. The calculation of the model then compared with the result of field measurements. The results showed that the texture of the soil layer 1 and layer 2: sandy clay loam and layer 3: sandy loam. The grafic comparison of simulated soil water content (KA) and the observation indicates that the simulation model of water content value (KA) increases the decline in value. Meanwhile the value of water content observation of layer 1 is always over the water content of layer 2 and 3. This is influenced by soil texture factor in each layer of the peanut plants land, because the texture of the soil also determines a water system in the soil like infiltration rate, rainfall, and water binding ability of the soil. Further research is necessary to observe the growth of plants as a result of the water content of the soil and to compare with the results of a model simulations.

Keywords : *CGM model, water content, soil texture, observation, simulation*

Introduction

In Indonesia, peanut is one of important vegetable protein source in people's food menu pattern. In productivity view, Indonesia is assessed still low. For reach high productivity, common plants need optimum growth factors. The factors are related by climate and soil. The rainfall and weather as climate elements are the environment that determine plant growth and productivity.

For plants, soil is affected for plants growth and flowering. Plants will optimum grow and flower if soil condition, its live place, is suitable with nutrition and element of nutrition needs. In plant cultivation, moisture condition (humidity) of soil as an effect of irrigation should be noticed because moist soil is good affected to plant growth. Moisture is also important to defend cell shape stability. Some soil factors have not static properties, by management and technology its quality can be changed and be fixed so it can be compatible with developing field using type.

The ability to measure and to control soil water supply to plants is the basic to increase efficiency of water using. Technology predicts soil moisture content in the field

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more easily. One of the methods is using CGM (Crop Growth Method). CGM is irrigation model which predicting soil moisture content based on daily climate data. The benefit of CGM is to stimulate secondary crop growth such as corn, soy bean, peanut, etc. (Vaze et al, 2004).

CGM which is commonly applied in foreign countries can be used to estimate soil moisture content based on daily climate data. For its use in Indonesia the CGM must be tested because a model that has been successfully applied in a particular area can not possibly be applied to other areas. This is related to climatic differences in each region. For example, the scheduling model of CGM is growing in the summer and winter. While in Indonesia there is no summer and winter so its use is adjusted to dry season and rainy season. Assuming that the summer is the dry season and winter is the rainy season. If the results of model simulations with observations are equal or nearly equal, it can be said CGM can be applied in Indonesia.

Beside the daily climate data obtained from the nearest station agroclimatology, CGM also requires land properties such as soil texture and thick layer of soil. So that the collection of data in the research area only limited to measure the thick layer of soil and determine the soil texture.

This paper aims to study how the CGM and to compare the water content of the model simulations with observations in the field.

Methodology

This research was done on April-July 2008 with observation location: field with peanut as wide as 32.5 m^2 in Cangkringan Village, Jenggawah, Jember and the data processing location: Research Centre Of Development Of Water Resources And Irrigation (PUSLIT PSDA) Jember University.

The data used in this research is daily climate data (minimum and maximum temperature, rainfall, and radiation begin in 1999-2007), soil sample is not disturbed to know bulk density (BV), soil sample is disturbed to know soil texture, dense of soil layer, soil water content, and peanut. The tool used in this research are: 1 set soil drill, program class software with CGM, Microsoft.NET 1.1 redistributable package, 1 set ring sample, hoe.

Determination location method in this research is determined by purposive method with considering private property of the field and using less cost because this method needs to cultivate and to harvest the field and it is not necessary to hire it. The model used in this research is CGM because CGM can be used to stimulate plant growth with just using five parameters. Thereby, this model expected can be implemented in Indonesia. The data used is primary and secondary data. The primary data required are to determine the dense of soil layer, soil moisture content, bulk density (BV), and soil texture. The secondary data required are evaporation data and daily climate data at period of 1999-2007.

The research design are: measuring the dense of soil layer, measuring soil moisture content, measuring bulk density (BV), measuring soil texture, daily climate data, and plant observation.

Research Step

Commonly, the research steps are:

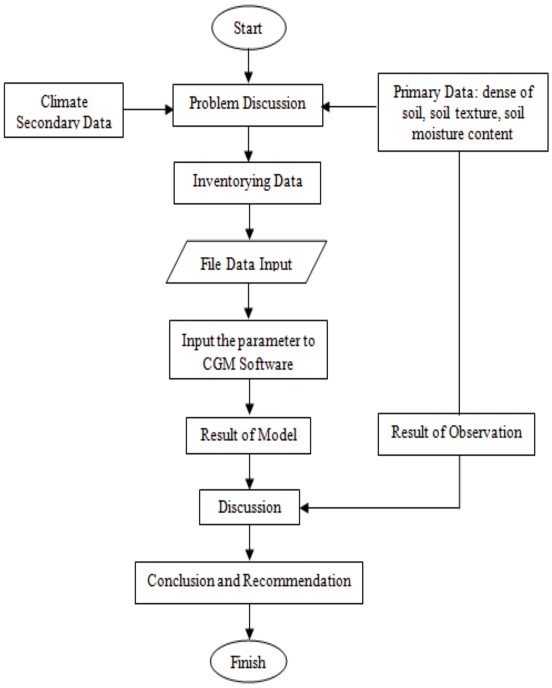

Figure 1. Flowchart of Research

The steps of data processing with CGM are:

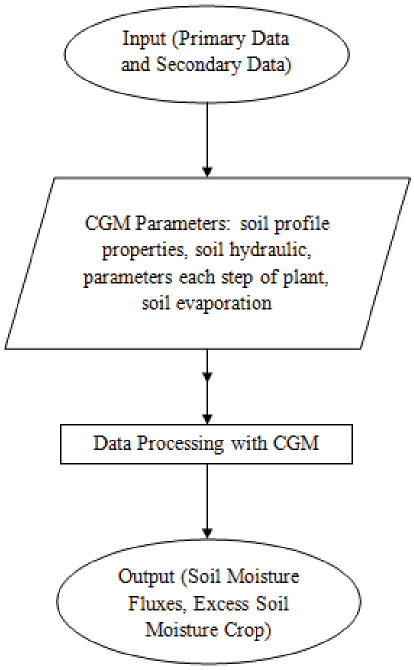

Figure 2. Steps of Data Processing with CGM

Result and Discussion

The agriculture and the availability of technology are needed to stimulate plant growth and flowering so it can increase crop production. There are four important components of farm enterprises interconnected that can increase crop production. Four components of farm enterprises to increase peanut production are:

1. Preparation of Land

One method is to cultivate the land. Intensive cultivation of land causes loose and crumb soil structure. Beside of soil cultivation, drainage channels need to be made to remove excess water and it could be as irrigation channel when the land required additional irrigation.

2. Planting Pattern

Land for this study is a wet rice field. According to Adisarwanto (2001), in wet rice field, peanut is usually planted after rice or first dry season (March/April-Mei/Juni) and the second dry season (Juni/Juli- September / October). Research was done on 17 April – 6 July 2008.

3. Planting

Peanut grows well if it is planted in minor or loose land (loamy sand, sandy, or clay). The land used for this research is land with sandy clay loam soil texture. Sandy clay loam soil texture is include soil type with sand percentage larger than the clay.

The result of measuring soil water content using vertically simulation model with soil water content every 10 day observation period of 90 days is influenced by a number of factor, that is the factor of soil texture in each layer of the peanut crop, because the soil texture contribute to determine water system in a soil infiltration rate, rainfall and water binding ability of the soil.

In the figure (3), simulation model of the direction of soil water content movement is nearly equal to the soil water content observation. It indicated that the soil water content in first layer for the simulation and the observation result has larger value than the soil water content in second layer, whereas the soil water content for observation result is equal with the value of soil water content in third layer for simulation result.

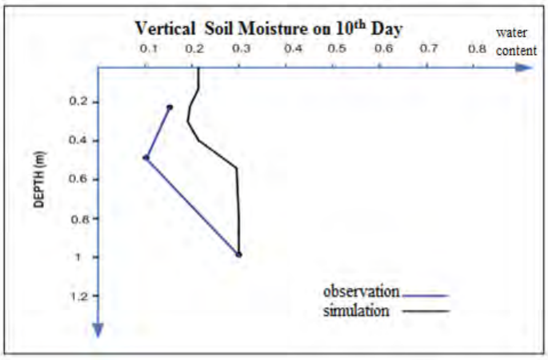

Figure 3. Vertical Graphic of Soil Moisture on 10^{th} Day

The texture of the soil in layer 1 and 2 are sandy clay loam soil types with sand percentage larger than the clay so the water will quickly pass into the layer below because the spaces between large grains and the holding capacity between land and water molecules (adhesion) are small so the water will quickly absorb into the layer below causing soil water content in layer 3 larger than in layer 1 and 2.

The soil water content in layer 3 is larger than in layer 1 and 2 because layer 3 is a land that has a sandy loam texture and coarse-textured soils, this texture contains attached to sand enough because of the dust and clay. Sandy loam soil has a large water holding capacity because it has a fairly dominant micro pore resulting strong interesting attraction between land and water molecules (adhesion) compared with the texture of the soil in layer 1 and 2. So the water that escaped from layer 1 and 2 will be accommodated in the layer 3. In addition, the layer 3 is at the bottom so that the influence of soil evaporation can be regarded as small or nothing because the layer 3 is not directly exposed to solar radiation.

The soil water content in layer 1 is larger than layer 2 because on the first 10 days have been occurred heavy rain in the rainfall reached 15.11 mm / day so the water will inundate the land, irrigation channels, and drainage. The evaporation also causes the value of soil water content in layer 1 and layer 2 because the water will rise to the soil surface to vaporize. As a result the water in layer 2 and 3 will be evaporated. However, the water is difficult to climb onto the surface because the texture of the soil in layer 3 is mostly clay. Therefore, the soil water content in layer 3 is larger than the soil water content in layer 1 and 2. While for plants, excess water on the first 10 days is very advantageous because the first 10 days the plants were in the embryonic phase and germination requiring a lot of water so that it will increase growth and flowering of plants.

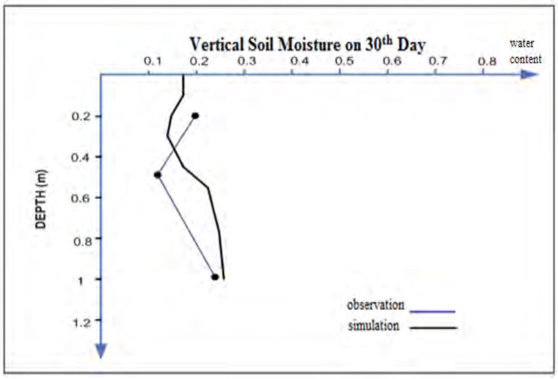

Figure 4. Vertical Graphic of Soil Moisture on 30th Day

On 30th day the soil water content in first layer for observation was larger than the soil water content value in first layer for simulation. On the 30th day, the rain was rarely occurred but figure (4) shows the soil water content for observation and model in layer 1 larger than layer 2. This is caused the influence of soil texture, evaporation and heavy rain on 10th to 20th day which the water had not diminished and the rain was occurred during the 20th to 30th day so that the amount of water will continued to grow. On 30th day, this day was the beginning of the vegetative growth that required quite a lot of water. This was very favorable for plant growth and flowering.

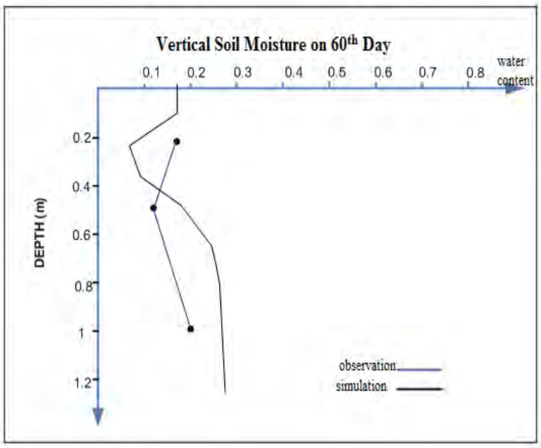

Figure 5. Vertical Graphic of Soil Moisture on 60th Day

In figure (5) fluctuation of soil water content is small. The soil water content in layer 1 for observation is larger than soil water content in layer 1 for simulation. This situation is also affected by rain for 60 days so that the amount of water continued to increase, the evaporation is occurred because the first layer is directly exposed to solar radiation with the texture of sandy soil caused by the dominant macro pores, the evaporation is also occurred because plant growth is supported by the increasing growth of plant roots. Increasing its number of roots, the ability to bind the particles of water increases. Therefore, the soil water content value in layer 1 is always larger than the value of the soil water content in layer 2. The value of soil water content in layer 3 is nearly equal to the value of soil water content in layer 1. Layer 3 is a bottom layer so that the possibility of water evaporation is very small although the water in the layer 3 will increase when evaporation was occurred in the layer 1 supported by sandy loam texture containing sufficient inherent sand because of the dust and clay.

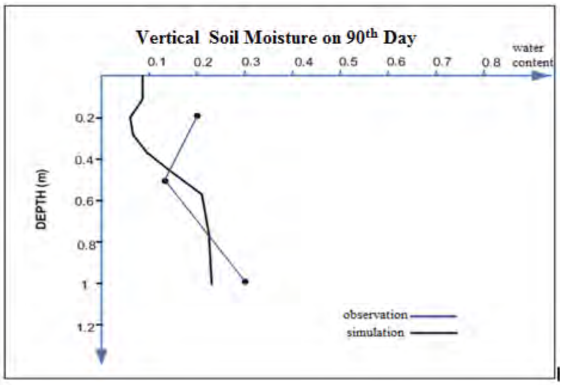

Figure 6. Vertical Graphic of Soil Moisture on 90th Day

On 90th day, the results of simulation model and observation of the soil water content in layer 3 is larger than the soil water content in layer 1 and 2 while the soil water content in layer 1 is larger than the soil water content in layer 2. Value of soil water content in layer 3 is larger than the soil water content in layer 1 and 2 because the soil in layer 3 has a sandy loam texture and it has coarse-textured soil, this texture contains enough sand inherent because of the dust and clay.

Likewise with the result of measurement of soil water content horizontal simulation model and measurement of soil water content observation have different value. This difference can be seen in Figure (7). Value of soil water content (KA) simulation model is longer its value progressively go down. While the values of KA observation in layer 1 and 2 are always below the value of KA model while the values of KA in layer 3 in the two last sampling are above the value of KA model. On 30th, 60th, and 90th day, the value of soil water content in layer 1 were up while the value of soil water content in layer 2 increased on 20th day and decreased again on 50th day and then increased again on 60th to 80th day. The last day of sampling, the soil water content was decreased.

The value of soil water content in layer 1 observations always larger than the value of soil water content in layer 2. As explained in the vertical measurement of soil water content that it is linked by environment factors such as rainfall, soil texture, evaporation, and plant influence. One of the environment factors affecting is acceptance of bigger or different water amount caused by rain and irrigation. The texture of sandy soil causes faster evaporation of soil because the soil has dominant macro poress so if it was exposed to solar radiation then the water will quickly evaporate. In terms of plant factor, layer 1 is a layer of soil in the root zone so it is stored more water. This is because the roots have a role to bind the water particles as a result of irrigation.

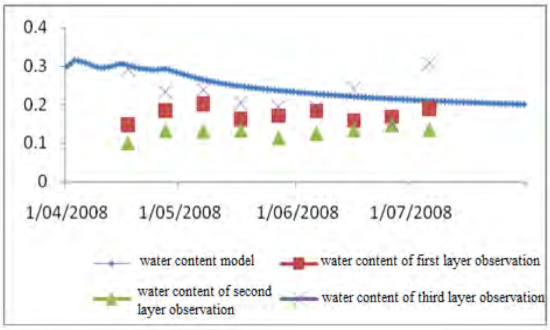

Figure 7. Relation Graphic of Water Content Model with Water Content Observation

CGM describes the total of ground cover, which the numbers of growing from the first planting to harvesting increase. Increasing ground cover is also effected by soil water content in the soil because the water will increase the growth of ground cover. Hence, it need to weed.

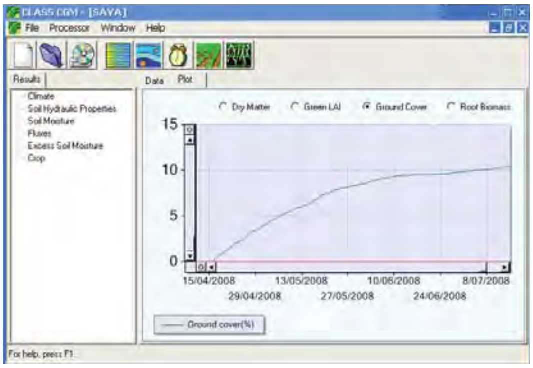

Figure 8. Graphic of Ground Cover

CGM also illustrates that the more days the ground covers increase. The growing of ground cover also affect the value of soil evaporation because the ground covers affecting the radiation of sunlight can not directly penetrate the soil surface. Here is a chart of daily soil evaporation with the ground cover based on the model (Figure 8) and evaporation based on the observation graphic (Figure 9).

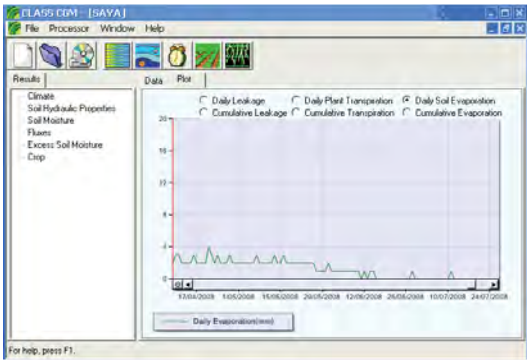

Figure 9. Graphic of Daily Soil Evaporation

Based on the graphic of the model shows the daily soil evaporation at the research site the value up and down until the harvest. While the observations of each layer of soil evaporation values always increase but the evaporation of soil each sampling point is up and down. This is caused by differences in sampling place (point) and acceptance of different light intensity due to the ground cover and the differences of soil water content . The layer 1 should have larger soil evaporation than the soil evaporation in layer 2 and 3 because the texture of the soil in layer 1 contains a lot of sand and it is directly exposed by solar radiation, but based on figure (10) soil evaporation in layer 1 is less than in layer 3 while soil evaporation in layer 2 equal with soil evaporation in layer 1. This condition is contrary to the condition of the soil water content and soil texture. The soil in layer 1 should have larger evaporation because the texture contains of much sand, on the other hand, layer 3 with sandy loam texture the soil evaporation is greatest.

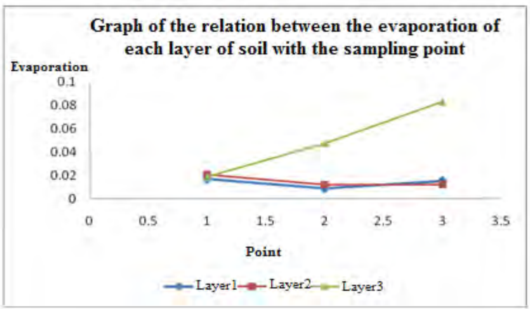

Figure 10. Graphic of Evaporation Observations

4. Harvest

In this research, harvest time was not right because it was too fast so that the quality and quantity of pods produced was few. Harvesting done early because the plants have been aged 90 days and in accordance with the plan of research, that research will be conducted for three months or 90 days.

It should be irrigated 2-3 days before harvesting. Because 2-3 days before harvesting it was not irrigated then the plants harvesting or extracting from the soil should be strong so that plants could be lifted and not left the pods in the soil. However, at the time of extraction still existed pods left in the soil. The irrigation was not done before harvesting because after the harvest is still to be made for removal or the last observation. If the land was watered before harvesting, the procedure for the last sampling is not the same as the previous procedure.

Conclusion

a. The longer simulation of water content value, the more decrease it will be. Meanwhile the water content value of first and second layer observation are always under the grade of water content and in the other hand the water content value in the third layer in the both sample takings are above the grade of water content value. In the 30th, 60th, and 90th days of the first layer were increase, and the water content of second layer was also increase in 20th day but decrease again in the 50th day and increase in 60th until 80th days again. The water content of the soil was decrease in the last taking sample. This was influenced by soil texture in every layer on that ground nut/peanut field, because soil texture also determine water system of soil by infiltration rate, rain fall, and water binding ability by the soil.
b. CGM (Crop Growth Model) is an irrigation model which estimated soil humidity and could be used for crops growth simulation such as peanut, corn, soybean, and others. By seeing the result, the CGM users in Indonesia seems not perfect yet because the result of model simulation and the result of observation in the field are not match and correlate. There are different seasons in Indonesia that becomes the problem. There are winter and rainy seasons in Indonesia, meanwhile the parameter of CGM is using winter and dry season. Therefore dry season assumes as summer and rainy season as winter.
c. CGM could be used for simulating the crop growth. CGM was applied in growth nut in this research. Through the use of CGM needs many inputs: daily climate data, soil layer thickness, and soil texture. The outputs of CGM are soil moisture, fluxes, excess soil moisture, and crop.

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