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RESEARCH ARTICLE

ADAPTATION AND EVALUATION OF CROPSYST MODEL ON SOYBEAN (*Glycine max* L) UNDER CLIMATE CHANGE

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ABSTRACT

The aim of research : (1) to verify the cropsyst plant model of experimental data in the field of soybean plants and (2) to predict planting time and potential yield soybean plant with the use of cropsyst model. This research is divided into several stages: (1) first calibration stage which is conducted in field from April until September 2016. (2) application models stage, where the data obtained from calibration in field will be included in cropsyst models. The required data models is climate data, ground data/soil data, also crop genetic data. The relationship between the obtained result in field with simulation cropsyst model indicated by Efficiency Index (EF) which the value is 0,784. This is showing that cropsyst model well used. From the calculation result RRMSE which the value is 2,351%. This is showing that comparative fault prediction results from simulation with result obtained in the field is 2,351%. Conclusion has obtained that prediction of soybean planting time cropsyst based models that have been made valid for use. and the appropriate planting time for planting soybeans mainly on rain-fed land is at the end of the rainy season, in which the above study first planting time (Mei 1, 2016) which gives the highest production, because at that time there was still some rain. Tanggamus varieties more resistant to slow planting time because the percentage decrease in the yield of each decade is lower than the average of all varieties.

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INTRODUCTION

Consumption of soy in Indonesia is increasing with increasing of population and prosperity of people who pay more attention to health. They are more looking for a source of protein from vegetable that consist of low cholesterol. The increasing of consumption cannot be fulfilled by domestic production. Domestic consumption is around 2.2 to 2.5 million [tons/ha] while national production only reaches 998,999 [kg/ha]. So it still has to be filled by imported soybeans (BPS, 2016). There are some environmental factors related to the lower productivity of soybean. Drought and flooding as results of climatic anomaly and climate change are the causal factors. Many sectors are affected by climate changes, and agriculture is the most susceptible sector related to extremely climate change. Ecosystem of rice and other food crops such as soybean are the common examples that impacted by extremely climate changes (Kaimuddin *et al*., 2013). To solve environmental problems, there are some requests to find integrated software or models that combined some variables from interdisciplinary approaches as solution models (Donatelli *et al*., 2014). Models or software which can simulate plant growth and development on the varied crop management are opportunity in the global modernization of agricultural production. Some models can describe the plant responses on the different environment and crop management (Singh *et al*., 2008; Evett and Tolk, 2009). CropSyst is one of models that can describe some concepts in the agriculture for future (Stöckle, 2014). This model was used to predict or simulate the growth and development of the selected plants or crops on the selected soil. It produce model that can estimate the potential crop production on the specific climatic and soil condition (Republic of Serbia, 2013) and it`s the first step for adaptation of crops on the cropping system (Stöckle *et al*., 2012). This model was applied on some crops and areas (Singh *et al*., 2008; Palosuo *et al*., 2011; Rotter *et al*., 2012). Calibration and validation are needed as preliminary procedure before CropSyst will be applied on the various environmental conditions. Based on that condition, so it's necessary to get the better strategy of soybean management to cope the extreme climate change by using CropSyst. This research was needed because mitigation and adaptation of climate change on agriculture sectors are the latest issues in the world, especially food crops are very susceptible to climate change

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MATERIALS AND METHODS

This research were divided into two stages based on the use of CropSyst models. The first stage was calibration stage and the next stage was application (preparation and test *Relative Root Mean Square Error*/RRMSE). Calibration stage was conducted in field from April to September 2015, in Bureau of Meteorology Climatology and Geophysics (BMKG) in Maros District. Split-plot design was adopted in the research that consisted of treatment variety (V) as the main plot and planting time (W) as subplot. There were three varieties, such as Tanggamus (V1), Wilis (V2) and Anjasmoro varieties (V3). Planting times were divided into four times, namely 1 Mei 2016 (W1), 11 Mei 2016 (W2), 21Mei 2016 (W3) and 31 Mei 2016 (W4). Growth Degree Days (GDDs) were observed from planting to harvest period. Plant phenological variables such as *Emergence, End Canopy Growth, Early Flowering, Early Seed Filling, Early Senescence*, *Maturity* and *Completed Senescence* were also recorded. Application model was conducted after calibration stage. In this stage, the data obtained from calibration/verification in field were then used in CropSyst models.

RESULT AND DISCUSSION

Calibration Stage

Calibration is a process to select the combination of variables or to change the plant and soil variables for fixing of variables in the model and then collecting of plant variables that needed in the model. On calibration stage (parameterization CropSyst model) was done by the comparing the simulation and current values that obtained on the field, and then changing the sensitive variables to get the best results that closed to the actual results on field. This stage aimed to see the accuracy of model related to condition of growth and development stages of soybean (from emergence to harvesting phases). Seven phases of soybean growth and development were observed in this research such as: 1) emergence, 2) end of canopy growth, 3) early flowering, 4) early seed filling, 5) early senescence, 6) maturity and 7) completed senescence phases. The relationship data between observation result in field/current and simulation result on every treatment were described in Table 1. Based on validation, CropSyst was suitable to be used as simulating tool for soybean. It`s showed by Efficiency Index (EF) with value 0.784 that obtained from actual production in field and simulation CropSyst model result. This model can be used to predict the production based on suitable planting time. RRMSE resulted 2.351%, it showed that there was 2.684% prediction error between actual and simulating results. Wijayanto (2010) reported that the lowest prediction error was produced by simulating model using variable`s values which obtained from previous research (Bellocchi *et al*., 2000). On his result, the lowest prediction error obtained the high value of EF (0.97). High value of EF and the lowest value of prediction error are the main indicator that CropSyst can use to predict crop production based on Nitrogen (N) application. However this research was applied in the small area (ca. 40 Ha), there are differences related to the differences in management.

Application model

In this stage, verification was conducted by using soybean as plant model on the CropSyst Program to predict the production of soybean for each treatment. After result of simulation was obtained, then comparison between simulation and actual productions for each treatment. Relationship between simulation and actual productions for each treatment were described in Table 1.

Table 1. Validation Result production data between simulation and actual observation for all treatment's combinations of soybean

Treatment	Simulation Observation	Plant Parameter	
		A	B
V1W1	S	1,059	2,119
	O	1,14	2,358
V1W2	S	0,714	1,428
	O	1,01	1,943
V1W3	S	0,507	1,014
	O	0,84	1,773
V1W4	S	0,356	0,711
	O	0,80	1,008
V2W1	S	1,052	2,105
	O	1,13	2,133
V2W2	S	0,749	1,497
	O	0,99	1,516
V2W3	S	0,614	1,228
	O	0,80	1,886
V2W4	S	0,54	1,08
	O	0,62	1,116
V3W1	S	1,074	2,147
	O	1,18	2,182
V3W2	S	0,803	1,606
	O	0,98	1,598
V3W3	S	0,51	1,02
	O	0,70	1,175
V3W4	S	0,483	0,965
	O	0,59	1,001

Remarks: Simulation (S) and Actual Observation (O)

Result showed that model of soybean production can predict actual production of soybean and there were correlation between simulation and actual production, with the value 0.784 (Figure 1). It mean that this model was suitable for soybean.

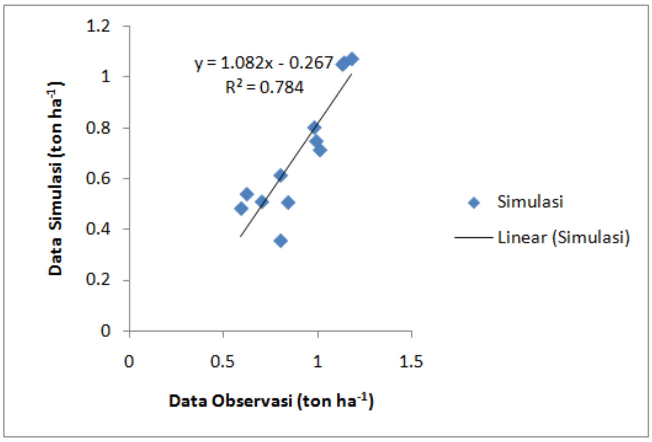

Figure 1. Verification result between Simulation and actual productions for three varieties of soybeanon the four planting times in Maros District

Based on verification between actual and prediction data, the high production was resulted at the first planting time (1 Mei 2016), and production decreased at more long planting time. This condition is related to rainfall intensity, where the first planting time got the highest intensity of rainfall. The second (11 Mei 2016), third (21 Mei 2015) and fourth (31 Mei 2016) planting times were no rain. In addition, the highest production was resulted by treatments of soybean varieties such as

Tanggamus, Wilis and Anjasmoro at the first planting time. As conclusion, growth, development and production of soybean are related to the planting time. If soybean are planted at uncorrected planting time, it will cause some problems, such as:

- Pest attack, in example: the fly nut will be outbreak, if soybean are planted at 2-4 weeks different than others. To solve the problem, it`s better to plant soybean at the same planting time. In case of disease, Hong *et al*. (2012) reported that delayed planting time up to 15 days reduce the intensity of bacterial disease on soybean. Related to this condition, it`s better to use the resistant cultivar if the planting time were on the different planting times. If susceptible cultivar were used, the delayed planting time and fungicide application are suggested to reduce the bacterial disease intensity on soybean.
- Drought as result of delayed planting time, Hu *et al*. (2011) reported that the delayed planting time on the unsuitable climatic condition contribute to the lower quality in soybean growth, development and production. In addition, lower quality of seed will be resulted because of the changes in oil and protein contents.
- Water also contribute to growth, development and production of soybean. Aminah *et al*. (2013) reported that the sufficient water during vegetative stage, and the lower volume of water during generative stage (flowering and ripening of seed stages) increase the production of soybean.

Conclusion

Prediction soybean planting time cropsyst based models that have been made valid for use. The right planting time for soybean especially on rainfed land is when the end rain season. Where the research when first planting time (1 Mei 2016) which resulted. Tanggamus varieties more resistant to slow planting time because the percentage decrease in the yield of each decade is lower than the average of all varieties.

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REFERENCES

Aminah, Kamaruzaman Jusoff, St.Hadijah, Nuraeni, Reta, S.Palad Marliana, A.Hasizah, Maimuna Nonci. 2013. Increasing Soybean (*Glycine max* L) Drought Resistance with Osmolit Sorbitol.Modern Applied Science; Vol. 7, No. 9; 2013 ISSN 1913-1844 E-ISSN 1913-1852. Doi: 10.5539/mas.v7n9p78. http://dx.doi.org/10.5539/mas.v7n9p78.

Badan Pusat Statistik (BPS). 2016. Tanaman Pangan. http://www.bps.go.id/tnmnpgn.php. Diakses pada tanggal 15 Mei 2016

Bellocchi G, M Ashman, L Shevtsova, M Donatelli, P Smith, V Romanenkov, J Smith and G Dailey. 2000. Using CropSyst and SUNDIAL to simulate soil organic matter dynamics at two sites in Eastern Europe. 3rd International Crop Science Conference, 17-22 August, Hamburg, Germany, 44.

Donatelli, M., Bregaglio, S., Confalonieri, R., De Mascellis, R., Acutis, M., 2014.A generic framework for evaluating hybrid models by reuse and composition:a case study on soil temperature simulation. Environ.Model.Softw.xxx, 1e9.

Evett, S.R., Tolk, J.A., 2009. Introduction: can water use efficiency be modeled well enough to impact crop management? Agron. J. 101, 423–425.

Hong Jeum Kyu, Chang Hyun Sung, Dong Kwan Kim, Hong-Tai Yun, Woosuk Jung, Ki Deok Kim. 2012. Differential effect of delayed planting on soybean cultivars varying in susceptibility to bacterial pustule and wildfire in Korea. Crop Protection. Vol. 42, pages 244-249.

Hu Mengxuan, Pawel Wiatrak, 2012. Effect of Planting Date on Soybean Growth, Yield and Grain Quality. Agroromy Journal Vol. 104 No.3, p. 785-790

Kaimuddin, Kamaluddin, A., Sasmono M.S. 2013. Analisis Tingkat Kerentanan, dan Adaptasi terhadap Perubahan Iklim berbasis Ekosistem Padi di Sulsel. Laporan Penelitian oleh Badan Penelitian dan Pengembangan Daerah Propinsi Sulawesi Selatan.

Mohammed,M. A. 2012. Impact of planting dates, spaces and varieties on Infestation of cucumber plants with whitefly, *Bemisia tabacci* (Genn). *The Journal of Basic & Aplied Zoology Volume 65, Issue 1, Januari 2012, Pages 17 – 20. DOI: 10.1016/j.jobaz.2012.01.003*

Palosuo, T., Kersebaum, K.C., Angulo, C., Hlavinka, P., Moriondo, M., Olesen, J.E., Patil, R.H., Ruget, F., Rumbaur, C., Takáˇc, J., Trnka, M., Bindi, M., Caldaˇg, B., Ewert, F., Ferrise, R., Mirschel, W., Ș aylan, L., ˇSiˇska, B., Rötter, R.P., 2011.Simulation of winter wheat yield and its variability in different climates of Europe: a comparison of eight crop growth models. Eur. J. Agron. 35, 103–114.

Republic of Serbia, 2013. CropSyst Model and Model Testing for Use in Serbia. Technical Workshop on Crop Yield Forecast in See, Skopje, Macedonia 30-31 May 2013

Rötter, R.P., Palosuo, T., Kersebaum, K.C., Angulo, C., Bindi, M., Ewert, F., Ferrise, R., Hlavinka, P., Moriondo, M., Nendel, C., Olesen, J.E., Patil, R.H., Ruget, F., Takáˇc, J., Trnka, M., 2012. Simulation of spring barley yield in different climatic zones of Northern and Central Europe: a comparison of nine crop models. Field Crops Res. 133, 23–36.

Singh, A.K., Tripathy, R., Chopra, U.K., 2008. Evaluation of CERES-wheat and CropSyst models for water–nitrogen interactions in wheat crop. Agric. Water Manage. 95, 776–786.

Stöckle, C.O., Armen R. Kemanian , Roger L. Nelson , Jennifer C. Adam , Rolf Sommer , Bryan C.arlson. 2014. CropSyst model evolution: From field to regional to global scales and from research to decision support systems. http://dx.doi.org/10.1016/j.envsoft.2014.09.006.1364-8152/© 2014 Elsevier Ltd. All rights reserved.

Stöckle, C.O., Higgins, S., Kemanian, A., Nelson, R., Huggins, D., Marcos, J., Collins. 2012. Carbon storage and nitrous oxide emissions of cropping systems ineastern Washington: a simulation study. *J. Soil Water Conserv*. 67 (5): 365-377.

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