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ОЦЕНКА МОДЕЛИРОВАНИЯ УРОЖАЯ DSSAT: В ПРОГНОЗИРОВАНИИ РАЗВИТИЯ КАЧЕСТВА И УРОЖАЙНОСТИ

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Реферат. Система поддержки принятия решений при передаче агротехнологий (DSSAT) использовалась для моделирования развития сельскохозяйственных культур и урожайности. Смоделировано влияние различных сортов и удобрений на урожайность пшеницы, а также влияние уровня азотных удобрений на урожайность пшеницы. В 2008/09 и 2009/10 гг. результаты моделирования были отличными, с эффективностью моделирования 0,99; Для сравнения, в 2007/08 году эффективность моделирования составляла всего 0,85. Количество дней до созревания и физиологической зрелости было хорошо оценено на основе данных калибровки с нормализованной среднеквадратической ошибкой (nRMSE) в диапазоне от 0 до 5,79%. Прогнозирование DSSAT CSM при различных условиях окружающей среды, сроки посадки, сорта и удобрения, используемые для моделирования развития сельскохозяйственных культур, и урожайность были найдены в соответствующих статьях конкретной модели.

Ключевые слова: модель DSSAT; агрономический менеджмент; продуктивность; окружающая среда.

DSSAT CROP SIMULATION MODEL EVALUATION: IN PREDICTING CROP DEVELOPMENT, AND YIELD

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Abstract. The Decision Support System for Agrotechnology Transfer (DSSAT) was utilized to simulate crop development, and yield. The impact of various varieties, and fertilizers on wheat yield, as well as the impact of nitrogen fertilizer level on wheat yield were simulated. The findings with the simulation quality were excellent in 2008/09 and 2009/10, with modeling efficiencies of 0.99; in comparison, the simulation efficiency in 2007/08 was just 0.85. The days to anthesis and physiological maturity were well estimated based on the calibration data, with normalized root mean square error (nRMSE) ranging from 0 to 5.79%. The prediction of DSSAT CSM under various environmental conditions, date

planting, varieties, and fertilizers used to simulate crop development, and yield were searched in the specific model relevant articles.

Key Words: DSSAT Model; Agronomic Management; Productivity; and Environment.

1.0. Introduction. The most crucial factor to consider when making decisions is the ability of crop simulation models, such as the agricultural production system simulator, to save time and resources through improved prediction accuracy. The DSSAT model is a trustworthy crop simulation tool for forecasting the growth, development, and yield of various crops. A model is a condensed depiction of a system, which is a limited portion of a reality that has interacting elements (Qin et al., 2020). Crop Simulation Models (CSM) are computerized depictions of crop growth and development as functions of weather, soil conditions, and management techniques using mathematical equations (Hoogenboom et al., 2004). Crop models have become useful tools for predicting crop growth, development, and yields depending on climatic and environmental conditions and agricultural management, as traditional field approaches are time-consuming, costly, and lack generality (Jones et al., 2003). To make it easier to apply crop models in a systems approach to agronomic research, a global network of scientists working together on the International Benchmark Sites Network for Agrotechnology Transfer project first developed the DSSAT (Bagavathiannan et al., 2020). It also provides a framework for scientific cooperation through research to integrate new knowledge and apply it to research questions. The models greatly simplify and shorten the research processes of agricultural systems and are, therefore, suitable alternatives for field experiments, saving time and economic costs. Additionally, crop models have been widely employed to optimize farming management practices and provide technical guidance for farmers and decision-makers (Teixeira et al., 2017). Thus far, the DSSAT model has been widely used for yield gap analysis, decision and planning making, strategic and tactical management, and climate change research (Amouzou et al., 2019).

In this current study, I reviewed and summarized, DSSAT is a popular crop model used over 100 countries for more than 20 years. It is a microcomputer software package, that provides a shell program for the interface of crop-soil simulation models, considering data for soil, weather, and management strategies (Hoogenboom et al., 2019).

1.2. Purpose of the Review

The DSSAT–CSM simulates growth, development and yield of a crop growing on a uniform area of land under prescribed, on efficient utilization of Inputs to predict the production under the cropping system over time.

1.2.1 Objective:

To validate the applicability of the DSSAT crop simulation model for quantifying agricultural output, identify crop output gaps promptly, and reduce expenses through efficient management practices.

2. Methods Used

In this review I used the Google Scholar and Mendeley searchable scientific databases to conduct a literature search for pertinent peer-reviewed academic papers. These works are reviewed here in relation to a model. When properly calibrated, DSSAT has been used to successfully model on crop growth, development, and output in response to changes in varieties, climatic conditions, N fertilizer rates, planting densities, sowing dates, and pre-planting soil moisture conditions (Bagavathiannan et al., 2020).

2.1. Crop Simulation Modeling

Crop models have been more important in the fight against climate change for their ability to simulate crop output under various climatic scenarios (Hoogenboom et al., 2019). The International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) was created by University of Hawaii soil physicist Goro Uehara to boost agricultural output (Beinroth et al., 1984). It is plausible that the crop models in general and the challenges of structuring input and output files are unknown to the ecosystem surrounding DSSAT crop modeling. Jim Jones intended to provide an integrated platform for crop simulation when he built DSSAT (Jones! et al., 1998).

2.2 Model Quality Evaluation

DSSAT is composed of seven genetic parameters: P1V (vernalization sensitivity coefficient), P1D (photoperiod sensitivity coefficient), G3 (standard, non-stressed dry weight of a single tiller at maturity), G1 (kernel number per unit canopy weight at anthesis), and PHINT (phyllocron interval between successive leaf tip appearances) (Jones et al., 2003). Various indicators of quality were used to assess the simulations' quality. A summary of the modeling quality was obtained by plotting the measured data against the simulated values and displaying the linear regression, correlation coefficient should all be near 1:1 line.

3. Results and Discussion

3.1 Simulation Quality Physiological development and yield on of wheat

Grain Yield:

The modeling efficiency of the wheat yield simulation ranged from 0.93 to 0.91, suggesting that the poverty in the first year was not significantly worse than in the year after. The model's total positive bias of +132 kg/ha suggests that, on average, the yield was substantially greater than what the data really showed. Relative mean square error (RRMSE; 8.2%) was less than half of the 394 kg/ha development stage simulation result. The mean absolute error (Table 1) was 326 kg/ha.

Table 1. Model quality for wheat yield for 2007-2010 (harvest maturity, days after sowing)

2007-2010 Simulated Wheat Yield						
Year	Average	Bias	MAE	RMSE	RRMSE	EF[4]
	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(%)	
2007/2008	5090	+357	357	413	8.1	0.91
2008/2009	5040	-49	351	425	8.4	0.91
2009/2010	4364	+87	271	339	7.8	0.93
All Years	4831	+132	326	394	8.2	0.92

[1] MAE: Mean Absolute Error, [2] RMSE: Root Mean Square Error,
[3] RRMSE: Relative Root Mean Square Error, [4] EF: Model Efficiency.
Sources: (Wu et al., 2013)

Physiological development

The result of wheat varieties study indicated that CERES-Wheat model had excellently simulated the days from planting to physiological maturity for all examined varieties V1, V2 and V3 with nRMSE values 5.57, 4.18 and 5.47%, respectively (Figure 1). This result indicated that the quality of simulation due to accurately calibration.

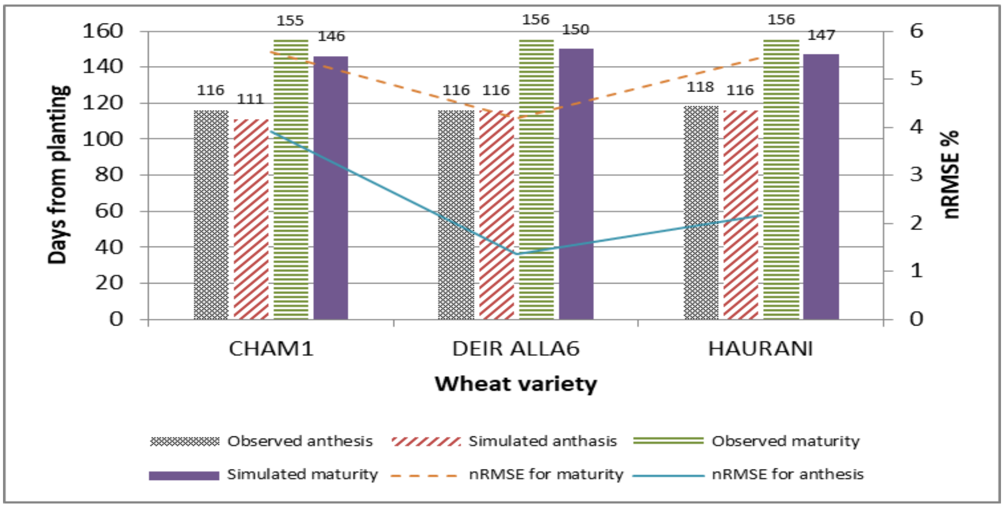

Figure. 1 Observed and simulated results for days to anthesis and days to physiological maturity for the studied varieties. Source: (Elgadi, 2019)

The simulation quality of the growth stage was excellent in 2008/09 and 2009/10, with modeling efficiencies of 0.99; in comparison, the simulation efficiency in 2007/08 was just 0.85. Additionally, the bias, mean absolute error, RMSE, and RRMSE all show same finding. The model's overall bias was somewhat negative (-3.4 days), suggesting that it took a little longer for the various growth stages to be reached. 10.5 days was the mean absolute error, 18.4 days was the RMSE, and 17.1% was the relative RMSE (RRMSE)

Table 2. Model quality for wheat yield for 2007-2010 (harvest maturity, days after sowing)

	Average	Bias	MAE [1]	RMSE [2]	RRMSE[3]	EF[4]
Year	(days)	(days)	(days)	(days)	(%)	
2007/2008	212	-16.7	17.3	29.3	29.9	0.85
2008/2009	225	+1.2	5.5	6.4	6.0	0.99
2009/2010	197	+5.3	8.7	9.4	8.3	0.99
All Years	211	-3.4	10.5	18.4	17.1	0.95

Sources: (Wu et al., 2013)

4. Conclusion

- According to this study, the DSSAT model is a useful tool for forecasting crop growth, development, and yield, which helps in decision-making.
- With overall model efficiency of 0.95 (growth phases), 0.85 (LAI), and 0.92 (yield), the simulation results for the three years of the wheat growth experiment in (2007–2010) and the model prediction of grain yield, and LAI with reasonable accuracy.
- To maximize crop yield, optimize resource use, and minimize environmental impact for long-term sustainable agricultural production, alternative management options that balance genotype, environment, and management (G * E * M) can be found within the DSSAT ecosystem.

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ЭФФЕКТИВНОСТЬ ВОЗДЕЛЫВАНИЯ ПОДСОЛНЕЧНИКА В ЗАВИСИМОСТИ ОТ МИНЕРАЛЬНОГО ПИТАНИЯ РАСТЕНИЙ

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Реферат. В статье представлены результаты изучения влияния минерального питания на экономическую эффективность возделывания гибрида подсолнечника. В ходе исследований установлено, что наиболее экономически эффективно возделывать подсолнечник при внесении