USE OF CROP GROWTH MODELS IN AGRICULTURE: A REVIEW

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ABSTRACT: *Crop Modeling is an artistic tool for risk management in Agriculture. Climate change, climate variability, carbon sequestration, long-term food security and environmental sustainability have become important issues in current scenario. Computer simulation models can make a valuable contribution to our understanding of the processes that determine crop responses and predict crop performance. Simulation models greatly facilitate the task of optimizing crop growth and deriving recommendations concerning crop management. They can also be used to determine the potential impact of climate change on future crop productivity, Climate smart agriculture development, mitigation and adaptation strategies. Climate variations, continuously increasing population pressure and market infrastructures are driven forces to reduce agricultural productivity. New management options and appropriate genotypes are need of the day to be considered for sustainable production. Crop simulation models are complementary tools in field experiments to develop innovative crop management systems. In this perspective, two crop growth models viz., APSM (Agricultural Production System Simulator) and DSSAT (Decision Support System for Agro Technology Transfer) were calibrated and validated to predict growth and yield under rainfed conditions for pothwar region of Pakistan.*

INTRODUCTION AND ITS APPLICATION

To determine the production and dry matter accumulation, the temperature and radiation are more important factors. The environmental conditions varies in each region, therefore, crop simulation model are used to give suitable decision for selecting variety in each region. The models provide good planting pattern and thermal time in each variety in each region. The simulation model operates daily and has four segments include light interception, leaf area index, dry matter production and seed yield Gholipouri *et.al.*, [1]. The model has capability to determine the accumulated dry matter production and leaf area index on daily basis. The leaf area index is more, when light interception will be more that is determine by models If above ground vegetative portion and harvesting index is more than seed filling will be good that is determine by crop simulation models Sridhara and Prasad [2]**.** The leaf growth is transfer from one stage to other stage can also be determining by using crop models.

Rinaldi *et.al.,* [3].stated that in irrigated area the estimation of crop water requirement and crop potential demonstrated that potential yield are determine the best tool of crop simulation models in agriculture decision making. The subjected to different irrigation schedules the OIL CROP – SUN model was first parameter to effective in simulating phenology, seasonal evapo-transpiration, seed yield and seed weight. This model is helpful in temporal change in soil water content, leaf area index and total dry matter. This model is good decision tool for comparing summer and spring sowing sun flower. The spring sun flower produced good seed yield and high return as compared to summer sowing in irrigated area Cabelguenne *et. al.*, [4]. Debaek [5] Debeak *et al.*,[6]. Rinaldi.[7] in areas where the shortage of water is more then management of water increase the water use efficiency, reduce the water losses through drainage, runoff. The changes occurred in soil productivity, soil degradation, soil erosion and nitrogen losses are identify and give better decision of crop simulation models.

Alagarswamy *et.al.,* [8] evaluated CROPGROW- Soybean models in semi arid tropical condition and also used in diverse environmental condition and give a better agriculture decision. These models are developing a yield and evapo-transpiration relationship and predict grain yield, biomass and leaf area index. When depth decreases from 90 to 67 cm than yield reduced, and when depth decreases below 45 cm then yield reduction increases. Many of scientists are invested in research in plant growth and architectural modeling and combining physical and biological process throughout world. Guo *et .al.,*[9] concluded that the model have ability to understand environment and standing plant interaction. New models gave new technology about plant structure, function, root and shoot system and will also give new information in future. Fourcaud *et al., [10]*in plant architecture, the nitrogen and phosphorus are present in soil in heterogeneous form but plant extend roots in soil layer to take the nutrients .Simultaneously the water and nutrients are transported in whole of plant for maintenance, expansion of exciting and initiation of new organs. In plant architecture the allocation of assimilate which determine growth rate of different organ. At the same time the plant is subjected to external mechanical stress are wind forces and gravity, and plant adopted its shape and structures. In plant 3D structure is factor for for integrating and understanding the relationship of whole plant and different organ Barthelemy and Caraglio.,[11].

Amjed *et .al.*,[12] concluded that no doubt traditional agriculture research have improving the crop management practices in developing countries due to shortage of resources. Science research organization cannot afford because the sudden change rise and fall in temperature, shortage of water, land degradation and soil erosion. The crop growth models are advance and new research tools and give better decision in agriculture. Research on small area

but model provides answer on whole of area but cost is minimum and provides answer before sowing the crop in any climate change. Jones *et .al.*,[13] concluded that increasing the population in developing countries but yield cannot increase by tradition methods therefore, the crop simulation method are essential tools increasing the agriculture yield but use the minimum resources. The crop simulation models are essential tool in field research and agriculture productivity in developed and developing country. In contrast, the observation of fields can be extrapolated in different conditions, other cultivar and other cropping systems. The increase CO_2 concentration in atmosphere and temperature changes are affected on crops therefore, crops simulation models are a give a better decision, yield prediction, agriculture planning and farm management. The models are ranging from imperical models which are used as calculate the daily temperature and predict yields, too very sophisticated models are try to describe the effect of growth and substance that are used in plant development Miglietta**.**F., and M.Bindi [14]. de wit, [15] demonstrated that the crop simulation models play important role to determine the growth, establishment and limits of agriculture production.

Gustavo *et.al.,* [16] demonstrated that Sunflower yield and oil quality interactions and variability analysis through a simple simulation model. The grain, oil quality and grain weight, oil percentage , fatty acid composition and amount antioxidants are validated by simple model but based on published relationship of yield and its components. The model provided good estimation of grain yield and oil quality from independent experiment. The difference in potential of yield, grain, oil percentage depends on locations, radiation and temperature. The crop simulation models give a answer any change in environment than ultimately sunflower yield is reduce and oil quality change. At lower latitude the sunflower oil with high nutritious and low yield but at higher latitude the sunflower produce high yield, high linoleic acid and oil production. These models facilitate the best sowing date, selection of variety, best location, population density and grain yield. Siskos *et. al.*,[17] concluded that increase in the demand of agriculture products with good qualities than main objective of these models to increase the sunflower production Cabrini *et al.*, [18] the amount of sunflower high percentage is determined by antioxidants and amount of fatty acid composition. The oxidative stability delay and decrease the nutritious value and development of unpleasant flavors but depend upon the proportion of olec acids (18:1) . Kris-Etherton and Yu.,[19] described that human health point of view poly unsaturated acids and have potent hypocholester olemic effects that decrese the risk of cardiovascular disease and milk fat concentration if conjugated linoleic acid . Langensiepen.[20] stated that the crop models are more reliable, widely acceptable and play important role in advancing international development. Models are used for the important process of plant growth, photosynthesis , soil and water environment. Langensipen *et al.* [21] observed that the agriculture research will be change to its mode of thinking from descriptive research to scientific theorization. The population increase in developing countries therefore the traditional agriculture research will not provide quick food supply, because it requires long time. The crop simulation models will reduce the time to suitable decision. McMaster and Wilhelm [22] concluded that the main objective of crop models is to predict the timing, growth rate, partitioning of assimilates into economic yield, requirement of essential water and nitrogen resources. The backbone of model are temperature and phasic development ,growing degree days and heat units Monteith [23] . The yield components and duration of phases determine by growth condition, the yield potential by geographic location and biomass calculated by radiation use efficiency.

The crop modeling is helpful to evaluate the recent advances and find to solution. Chapman *et.al.*, [24] Concluded that QSUN model are developed in early nineties that account irrigation, fertilizer and verities. In 2000 new models are introduced calculate the light interception, leaf area, leaf expansion, water deficit, stomata closure and maximum percentage of kernel in achene Peryar *et.al.*, [25] . The regional environmental limitation can be evaluated by using crop simulation model and prolong weather data. Boot *et.al.*,[26] ; Meinke *et .al.*, [27] demonstrated that when water and nutrient are sufficient quantity then maximum interception of solar radiation during growth season. But most important selecting the crop pattern. Assessing crop management options with crop simulation models based on generated weather data.

Soltani and Hoogenboom [28] conducted that under different experimental research the crop simulation models give best decision under different management practice. The main purpose of this study to evaluate the suitability of weather data that is generated by weather generators WEGN AND SIMMETEO are input of crop simulation models. In Iran wheat, maize and soybean were selected under different climatic condition decision support system for agro-technology transfer (DSSAT) were applied in this study using previous 30 to 90 years observed weather generated WEGEN and SIMMETEO. Tsuji *et al.*,[29] stated that using the agronomic practice for maximum crop production and using of optimizing natural resources that minimum creating the pollution. The decision support system for agro technology transfer (DSSAT) is a well known and widely used in all over the world for different crops. This software used for much research purpose around the world but mostly used to determine the crop management practices and fertilizer management (Alagarswamy *et al.,[*8].

Villalobos *et.al.,* [30] stated that important tools for agronomic management conditions and specific under rainfed conditions. These models are to evaluate organ biomass, nitrogen contents soil water daily time and leaf area index. The three cultivars are selected three important parameters which are synthesis of crop response to photo period and temperature during development and two cultivar are selected potential of grain number per capitulum and potential kernal growth rate. The model used for seasonal crop biomass and leaf area dynamics for rain fed and irrigated crops. Fereres *et al.*,[31] ; Meinke *et al.*, [27] ; Muchow and Bellamy, [32]; Sadras and Villalobos, [33]

.The sunflower in all over the world is important oilseed crop and mostly grown under dryland conditions.The models not only used for the agronomic practices but also used to differentiate among gynotypes in their developmental response to environment. Thorp *et. al* [34] evaulated that the prototype decision support system which is called Apollo was developed to assist the researchers in using the decision support system for agro technology transfer (DSSAT) crop growth models to analyze precision farming datasets. The purpose of DSSAT models are simulate crop growth and development within homogenous unit of land but the applo DSSAT has a special function to manage running the DSSAT models. Jones *et al.*,[35] demonstrated that the spatial yield variability occur within their fields but result of complex interaction among factors such are soil physical properties, drainage, nutrients and rooting depth. But most of variability occurs due to soil properties, the source of variability naturally exist that cannot be easily changed. The no of crops and regions are included in DASST family for use the stimulate the growth of different crops, which are including wheat, maize, rice and soybean. The DSST models are used for soil plat atmosphere and soil dynamics. The models are used for calculate the daily maximum and minimum temperature, solar radiation and rainfall. The crop management practice are variety, row spacing, fertilizer and irrigation Paz *et. al.*, [36].

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