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Testing the Sensitivity of Canegro Model for Variability in Temperature and Co_2 Concentration in Tarai Region of Uttarakhand, India

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A B S T R A C T

The present study was conducted at the Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar to study the impact of increasing temperature and Carbon dioxide concentration on the dry weight yield of sugarcane crop during the crop growing season of 2015 and 2016. The performance of the CANEGRO model was found to be satisfactory for all the crop characteristics during the crop growing season. The variety of sugarcane that was selected for the study was Co-Pant 5224. The model sensitivity was analyzed for parameters like maximum and minimum temperatures (°C) and Carbon dioxide concentrations (ppm). The temperature variations were applied from ±1 °C to ±3 °C and the CO_2 concentration was raised from ±50 to ±150 ppm. The sugarcane dry weight yield increased from 8277 kg/ha to 9561 kg/ha and decreased from 7057 kg/ha to 5954 kg/ha on increasing the temperature in 2015. While in the year 2016, the dry weight yield increased from 7759 kg/ha to 8499 kg/ha on decreasing the temperature while it decreased from 6938 kg/ha to 5372 kg/ha on increasing the temperature. The dry cane yield increased from 7834 kg/ha to 7986 kg/ha on raising the CO_2 concentration from 50 ppm to 150 ppm while it decreased from 7510 kg/ha to 6318 kg/ha on decreasing the CO_2 concentration in 2015. Similar was the trend found in the year 2016. The model was found to be sensitive to the effect of temperature either decreasing or increasing it than mean temperature and CO_2 concentration.

Introduction

India has the largest area under sugarcane cultivation in the world and it is the world's second largest producer of sugarcane next only to Brazil. Sugarcane accounts for the largest value of production and holds an enviable position among all the commercial crops in India. The crop encounters several changes in the yield and vegetative growth due to any change in the temperature than the optimum range. At higher temperatures reversion of sucrose into fructose and glucose may occur besides enhancement of photorespiration thus leading to less accumulation of sugars. Severe cold weather inhibits bud sprouting in ratoon crop and arrests cane growth. Temperatures lower than

0°C induces freezing of less protected parts such as young leaves and lateral buds. The two years ratoon was planted, keeping the Co-Pant 5224 sugarcane variety. CANEGRO, a crop simulation model, simulates sugarcane growth using weather and water inputs (Singels *et al.*, 2008). Based on process-based models of sugarcane growth and development including phenology, canopy development, tillering, biomass accumulation and partitioning, root growth, water stress, and lodging are also simulated. CANEGRO model was used for simulating the growth and yield of sugarcane during the crop growth period of 2015 and 2016. The model performance was found to be good for simulating the crop characteristics like LAI, Dry cane yield, biomass etc. The model was later tested for its sensitivity for parameters like maximum and minimum temperatures and CO_2 concentration.

Materials and Methods

A field experiment was conducted on "Testing the sensitivity of CANEGRO model for variability in temperature and CO_2 concentration in *tarai* region of Uttarakhand" was conducted during 2015 and 2016. The field experiments were conducted at the Norman E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S Nagar (Uttarakhand). Pantnagar is situated in the *Tarai* belt, at latitude of 29.2°N, 79.49°E longitude and at an altitude of 243.80 m above the mean sea level.

The variety of Sugarcane selected for the experiment was Co-Pant 5224. The model performance was also evaluated over parameters like Leaf Area Index and fresh cane yield (kg/ha). The statistical parameters like index of agreement (d), RMSE (%) and coefficient of determination (R^2) were computed to test how good the model performed in simulating different crop characteristics.

Sensitivity analysis is used to determine how "sensitive" a model is to the changes in the values of the parameters used in the model and to changes in the structure of the model. Sensitivity analysis helps to build confidence in the model by studying the uncertainties that are often associated with parameters. Many parameters in the system dynamics of the model represent quantities that are very difficult or even impossible to measure to a great deal of accuracy in the real world. Sensitivity analysis allows determination of level of accuracy for a parameter to make the model sufficiently useful and valid. If the tests reveal that the model is insensitive, then it may be possible to use an estimate rather than a value with greater precision. Sensitivity analysis can also indicate, which parameter values are reasonable to use in the model. If the model behaves as expected from the real world observations, it gives indications that the parameter values reflect, at least in part, the "real world" (Breierova and Choudhari, 1996).

In this study, the CANEGRO model was applied to a growing period of 2015 and 2016 in order to determine the model sensitivity on the changes in several meteorological parameters such as minimum temperature (°C), maximum temperature (°C) and CO_2 concentration In the model, the temperature variations were applied from ±1 °C to ±3 °C and CO_2 concentration changes were made from ±50 to ±150 ppm.

Experimental results

In this study, the CANEGRO-sugarcane model was applied to two consequent growing seasons (2015-16 and 2016-17) in order to determine the model sensitivity on the changes in several factors such as

maximum temperature (°C), minimum temperature (°C) and CO_2 emission concentration (ppm). In the model, temperature variations were applied from ±1 to ±3°C and CO_2 concentration from ±50, ±100 and ±150 ppm.

Effect of change in mean temperature (°C) on Sugarcane Dry weight yield (kg/ha)

The effect of mean temperature and CO_2 concentration have been presented in Figure 1 and figure 2 respectively.

Sugarcane dry weight yield showed a gradual decrease while the temperature was increased from 1 to 3°C. The sugarcane dry weight yield increased from 7691 kg/ha to 8277 kg/ha, 8887 kg/ha and 9561 kg/ha on testing the temperature sensitivity on the model from +1 to +3°C respectively in the year 2015. The dry weight yield dropped down to 7057 kg/ha, 6499 kg/ha and 5954 kg/ha when the temperature was dropped by 1, 2 and 3 °C respectively in the year 2016.

Sugarcane dry weight yield showed the similar trend when the temperature variations were applied from ±1 to ±3 °C. The yield varied from 7759 kg/ha, 8304 kg/ha to a maximum of 8455 kg/ha respectively on decreasing the temperature from +1 to +3 °C. While it deduced from 6938 kg/ha, 6103 kg/ha to a minimum of 5372 kg/ha when the temperature was dropped from -1 to -3°C respectively. The figure 1 clearly depicts the trend of dry weight sugarcane yield as impacted by temperature variations. The similar results were also reported by Samui *et al.*, (2003) in his findings that Higher maximum temperature was found detrimental causing reduction in yield. He carried out a study over eastern and western part of U.P. and found an increasing trend of sugarcane yield ranging from 30 t/ha in east UP. to 50 t/ha in west U.P. with favourable weather condition in west and northern parts of east D.P.

The higher maximum temperature in the range of 36 to 40°C which was much higher than the optimum temperature requirement < 36°C during germination to active growth stages was one of the reason for reduction in yield in east U.P.

Effect of change in CO_2 concentration (ppm) on Sugarcane Dry weight yield (kg/ha)

The model sensitivity was also tested when further changes were made in CO_2 concentrations. The CO_2 variations were made from ±50 to 150 ppm and it was found that the sugarcane dry weight yield increased on increasing the CO_2 concentration levels. Similar results have also been reported by Stokes *et al.*, in 2016. He stated that a simulation model of CO_2 effects, based purely on changes in stomatal conductance (indirect mechanism), showed transpiration was reduced by 30% (initially) to 10% (closed canopy) and yield increased by 3% even in a well-irrigated crop.

Table.1 Effect of temperature on dry weight yield of sugarcane (kg/ha)

Dates of Ratooning	At normal Tmean (°C)	Simulated dry weight cane yield (kg/ha)					
		Average change in temperature by					
		+1°C	+2°C	+3°C	-1°C	-2°C	-3°C
12 March 2015	7691	7057	6499	5954	8277	8887	9561
4 March 2016	7360	6938	6103	5372	7759	8304	8455

Table.2 Simulated dry weight yield values (kg/ha) at increased and decreased CO2 concentrations (ppm)

Dates of Ratooning	At current CO_2 conc. (ppm)	Simulated dry weight cane yield (kg/ha)					
		Average change in CO2 conc. (ppm) by					
		+50	+100	150	-50	-100	-150
12 March 2015	7691	7834	7966	7986	7510	7095	6318
4 March 2016	7360	7482	7481	7560	7187	6851	6174

Fig.1 Effect of Change in mean temperature (°C) on Sugarcane dry weight yield (kg/ha)

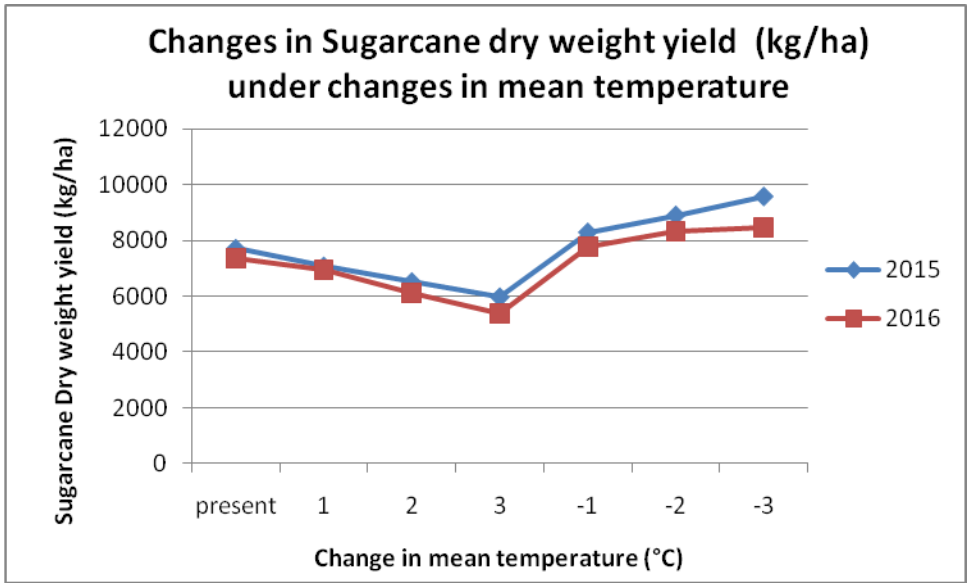
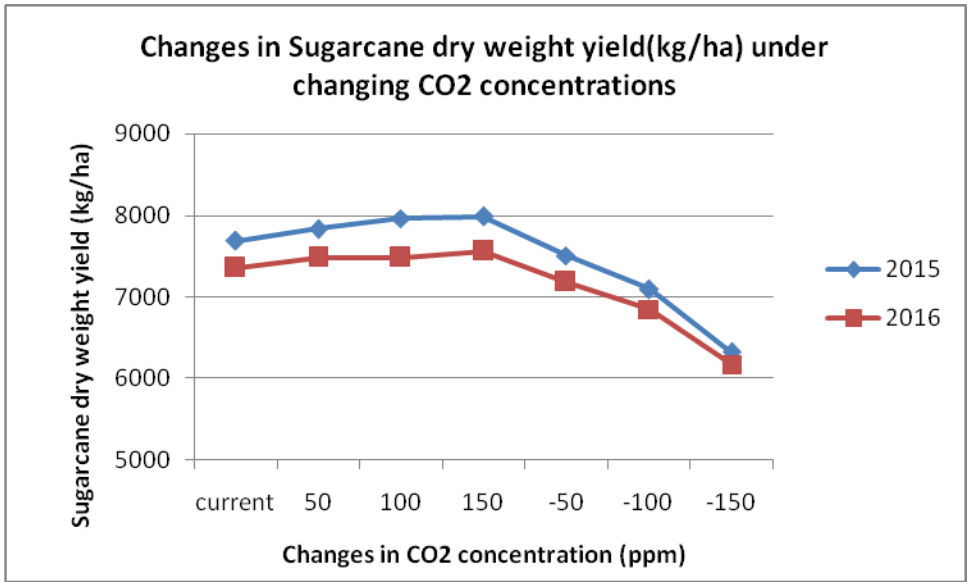


Fig.2 Effect of Change in CO2 concentration (ppm) on Sugarcane dry weight yield (kg/ha)



It is clearly evident from the Figure 2 that the Sugarcane dry weight yield increased from 7834 kg/ha, 7966 kg/ha and 7986 kg/ha respectively on raising the CO_2 concentration levels from +50 to +150 ppm from the current CO_2 concentration levels in the year 2015, while it decreased from 7510 kg/ha, 7095 kg/ha to a minimum of 6318 kg/ha respectively when the CO_2 concentration was decreased from -50 to -150 ppm.

Similar trend was observed during the studies that were made in the year 2016. The results revealed that the cane dry weight yield increased from 7482 kg/ha, 7481 kg/ha to a maximum of 7560 kg/ha respectively on raising the CO_2 concentration from 50 to 150 ppm. Also, it was found that yield decreased from 7187 kg/ha, 6851 kg/ha and 6174 kg/ha respectively when the CO_2 concentration dropped from 50 to 150 ppm.

In conclusion, sugarcane dry weight yield decreased with increasing mean temperature by 3 degree Celsius and vice versa during both the crop growing seasons. While it increased on increasing the CO_2 concentrations. The decreasing CO_2 concentration had downwelling impact on the dry weight cane yield and vice versa.

As per the DSSAT crop model, it was observed that the model is sensitive to any changes in the parameters like mean temperature and Carbon-dioxide concentration.

References

Breierova, L. and Choudhary, M., (1996). An introduction to sensitivity analysis. System Dynamics in Education Project, System Dynamics group, Sloan School of Management, Massachussets Institute of Technology, pp: 41-107.

Samui, R.P., John, G. and Kulkarni, M.B. (2003). Impact of Weather on Yield of Sugarcane at Different Growth Stages. *Jour. Agric. Physics*, Vol. 3, No.1 & 2, pp. 119-125.

Singels, A., Jones, M. and Van, D.B. (2008). DSSAT v4.5 CANEGRO Sugarcane Plant Module: scientific documentation, 34. Mount Edgecombe: SASRI.

Stokes, C.J., Inman, N.G., Everingham, Y.L. and Sexton, J. (2016). Measuring and modelling CO2 effects on sugarcane. Environmental Modelling & Software 78 (2016) 68-78.

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