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Short communication

Impact of imposed climate variation on rice productivity in Baroda district of Gujarat

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Simulation models provide a scientific approach to study the impact of climate change on agricultural production and world food security. Properly validated crop simulation models could be used with confidence to combine the environmental effects on crop physiological processes and to evaluate the consequences of such influences. Here, an effort has been made to test the DSSAT (CERES-Rice) model in terms of mathematical logic and stability to extreme values of weather parameters. The weather parameters selected for this purpose were ambient temperature (± 1 to ± 3°C), solar radiation (± 1 to ± 3 MJm^{-2} day^{-1}) and concentration of carbon dioxide (100 TO 300 ppm higher concentration to base concentration of 330 ppm). The model simulated rice grain yields under altered weather condition have been compared with corresponding observed yields averaged for the year 2004 and 2005. The base yield was obtained from the "Crop Acreage and Production Estimate of Major Crops", Directorate of Agriculture, Gujarat State, Gandhinagar for Baroda district.

Baroda is located at 27° 12' N latitude, 77° 27' E longitude at an altitude of 160 m above sea level. Two crop growth simulation models were also evaluated for testing their worth for forecasting yield. The crop growth simulation model Decision Support System for Agrotechnology Transfer (DSSAT) documented by Jones *et al.*, (2003) was evaluated and utilised for the said purpose.

The effects of change in ambient temperature, solar radiation and CO_2 concentration on simulated grain yield of rice under prevailing conditions and the comparison of this simulated grain yield with base yield and its per cent change from base yield are presented in Table 1.

Data revealed that there was linear yield decline due to increasing ambient temperature and linear increase in yield due to decreasing ambient temperature. Higher ambient temperature increases the rate of respiration and thereby reduce the amount of stored food material in the form of grain. Such a behaviour of the model was mainly due to reduction in duration of anthesis and grain filling with rise in ambient temperature and vice versa (Aggarwal and Mall, 2002; Akula *et al*., 2005). Saseendran *et al*., (2000) reported that for every one degree increment there was about 6% decline in rice yield. Hundal and Kaur (2004) and Easterling and Apps (2005) found negative effect of increasing temperature on rice yield. Patel and Shekh (2006) also stated on the basis of sensitivity analysis of CERES-Wheat that elevated maximum temperature decreased wheat yield significantly. Poussin *et al.*, (2003) opined that cold temperatures induced slower development rate. This resulted in increased anthesis and grain filling duration.

Results showed that with increase from 1 to 3 MJm^{-2} day^{-1} solar radiation, percentage yield increased from 10 to 15 in comparison with base yield. Highest yield increment was observed at 3 MJm^{-2} day^{-1} (15.3%). In case of gradual reduction in solar radiation, gradual decrease in yield in terms of per cent change from base yield was noted as 9 to 42 per cent for reduction in solar radiation by 3 MJm^{-2} day^{-1}. Kropff *et al.*, (2003) concluded that the yield decline in rice was mainly associated with reduced solar radiation.

The data presented in the table indicated linear increase in rice yield with elevated CO_2 concentration. Higher CO_2 concentration resulted in increased photosynthesis leading to higher yield. Patel and Shekh (2006) observed that increased concentration of CO_2 had a significant and positive impact on the grain yield of wheat.

The model simulated rice grain yields under altered weather condition compared with corresponding observed yields showed that increased ambient temperature decreased rice yield linearly and vice versa. Reverse was the case with solar radiation regime. Rice yield increased with elevated CO_2 concentration.

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Table 1: Effect of changed ambient temperature (°C), solar radiation(MJ m^{-2} d^{-1}) and CO_2(ppm) concentration on rice yield

		Yield (kg ha^{-1})	Change (%) over base yield
Ambient temperature(°C)	+3	1353	21.7
	+2	1208	8.6
	+1	992	-10.8
	-1	1193	7.3
	-2	1388	24.8
	-3	1643	47.8
Solar radiation(MJ m^{-2} d^{-1})	+3	1224	10.1
	+2	1276	14.8
	+1	1282	15.3
	-1	1011	-9.1
	-2	851	-23.4
	-3	637	-42.7
CO_2 concentration(ppm)	100	1295	16.5
	200	1321	18.8
	300	1335	20.1

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