Journal of Energy Research and Environmental Technology
Print ISSN: 2394-1561; Online ISSN: 2394-157X; Volume 1, Number 1; November, 2014 pp. 6-10

http://www.krishisanskriti.org/jeret.html

Impact of Climate Change under A_2 Scenario on Potato Yield for Anand District, Gujarat Thematic Area: Climate Change and Agriculture

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Abstract: **The impact of climate change on agriculture sector is well known. Agricultural output of tropical region will be reduced due to increase in temperature and large uncertainties in monsoon pattern. In view of this fact it is high time to evaluate regional crop response to projected climate change. Various adaptations measures and introduction of temperature/drought tolerant cultivars will alleviate the impact of climate change on agricultural crops. The climate change impact assessment on Potato, of Anand weather station (22^0 32' N latitude and 73^0 00' E longitudes) was worked out using the PRECIS model output in A_2 scenario and baseline data. Potato yield simulation for projected and baseline period was carried out using the DSSAT crop simulation model. The DSSAT model was calibrated and validated for Potato (Kufri pukhraj) using experimental data (year 2013-14) of cultivator, in Boriavi- Anand. The study was extended to regional level for Anand district for simulation of Potato yield using DSSAT model by PRECIS output under A_2 scenario (2070 to 2100) and baseline (1960 to 90).Potato yield, Total biomass during crop cycle, leaf area index-test weight were satisfactorily simulated by DSSAT model, however LAI was underestimated and rest of the parameters were overestimated by the model with reasonable agreement. This shows the robustness of DSSAT model. Proper calibration of DSSAT model works well for yield simulation during projected period. Weather condition as generated by PRECIS model for Anand district showed that there will be rise of Tmax and Tmin at a rate of 0.003 and 0.002 ^{0}C/year. Under A_2 scenario Climate On simulation study results it decline about 35% average period of time fame Of 30 year of period As the Production of potato is decrease side by side the phonological stages also disturbed as outcome of present study**

Keywords: **Potato, DSSAT, Simulation**

1. INTRODUCTION

Climate change refers to long term conspicuous deviation from usual prevalent climate bringing variation in normal temperature, rainfall and atmospheric circulation with abnormal expression in extreme climate such as floods, droughts, extreme temperatures etc. can be termed as climate change (Ghadekaret al,2001).

Climate change is expected to affect agriculture very differently in different parts of the world. The resulting effect among various continents depend on climatic and soil condition, availability of resource and infrastructure use to cope with climate change the difference are also expected to greatly influence the responsiveness to climate change.

The Gujarat state produces about 1.88 m. MT of potato from anarea of65300 hector. With a productivity of 28.17 t/ha whichis the second highest in the country after West BengalAs per year 2011-12 stat governmentstatistic's.Anand district produce 0.19million Metric Tons from 6100 Acer .The concentration of production in the state is at Khera,Dissa, BananshKatha, Vadodara and Mehsana districts potato have been traded in organizedmarkets.

Various crop models are being used optimizingnatural resources to assess the impact of future potentialclimate on crop production (Rosenzwieg and Iglesias, 1998; Rao and Sinha, 1999; Rosenzwieg and Parry,1994). Assessment of impact of climate change on cropproduction using simulation approach is usuallyassociated with two uncertainties One deals withpredicting climate change scenarios using GeneralCirculation Model (GCM).The other relate tosimulation models themselves. Simulation Model play significant role in Climate Change Impact Study.

2. MATERIAL AND METHOD

2.1 Data requirement for DSSAT model

The DSSAT (Decision Support System for Agrotechnology Transfer) Model required following data set for simulation study.

2.1.1. Weather data

The DSSAT model require dailyweather data of maximum and minimum airtemperature, solar radiation, vapour pressure, windspeed and rainfall. For calibration and validation ofthe

model, observed weather data were obtained fromAgro. Met. observatory, Dept. of Agricultural Meteorology, Anand Station,AAU, Anand.

2.1.2. Soil data

Top layer soil data file of similar texturesandy Loam (Goradu soil) were modified in Master usingactual soil data of experimental site.

2.1.3. Crop management data

All the crop managementdata required by the model were obtained from Experimental Field on one Hector Potato Crop Boriavi-Anand.

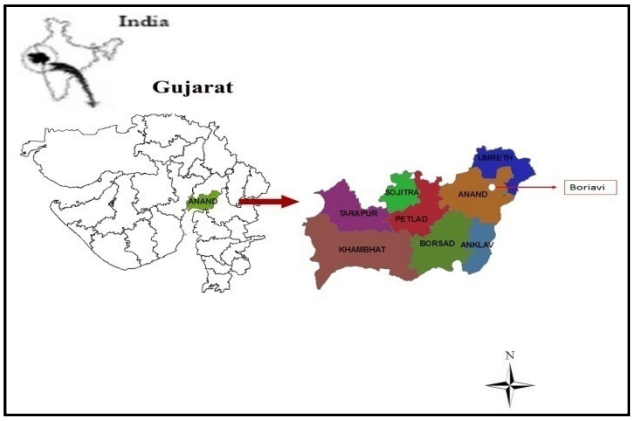


Fig. 1: Study area

2.1.4. Calibration and validation of the model

The fieldexperiment data on Kufri Pukhraj Of the year 2013-2014 have been used to calibrate andvalidate the model. Irrigation Fertilizer, soil And Weather Parameter considered In Simulation Study.

2.2. Climate change study

For climate change impact study, weather data forA2 scenario was derived from PRECIS downscaledModel prepared by IITM Pune in a grid size of 0.4Degree and was obtained as part of NetworkProject Anand Agriculture University. All Meteorology Data collected form Anand Weather Station Anand Agriculture University.

2.3. Handling of climatic data

Two period of 30 years each, one for base linei. e., 1961-1990 (base line period) and another for A2projected scenario i.e., 2071-2100 (projected scenario)were considered for climate change impact study. Thereare gross difference between PRECIS base line dailyweather data and actual weather data for the sameperiod. With assumption and common consensus in thenetwork project, about the difference between PRECISbase line (1961-1990) and projected (2071-2100) is tobe relied for climate change, thirty year monthlyaverage of daily weather parameters of base line datawas subtracted from corresponding projected A2scenario data and the difference obtained were used forcomputing weather data for projected period usingactual observed data. In case of rainfall, no satisfactorymethod evolved but percentage difference on monthlysum of 30 years average data, between projected outputand base line output were used as correction factor aspracticed in Network project.For base line data, actual weather data for 30year period were used. For computing weather data(except rainfall) for projected period from actual data ofbase line period, the following Equation scheme was used(H.R. Patelet al, 2012).The Rain fall is neglected hence the potato is winter crop.

$$Xpni = Xoni + \Delta i + (\Delta i + 1 - \Delta i) * n/Ni$$

$\Delta i = Api - Abi$

Xpni= Weather parameter of nth day starting from middle (15^{th}) of i^{th} month for projected period (2071-2100).

Xoni= Observed weather parameter of n^{th} day starting from middle (15^{th}) of i^{th} month for baseline period (1961-1990).

Api= Average of 30 years (2071-2100) monthly average of daily weather parameter for projected period.

Abi= Average of 30 years (1961-1990) monthly average of daily weather parameter for base line period. For computation of rainfall data:

Rpni= Roni*(1+(Rpi avg – Roi avg)/Roi avg)

Rpni= n^{th} day (from beginning of month) computed rainfall of i^{th} month for projected period.

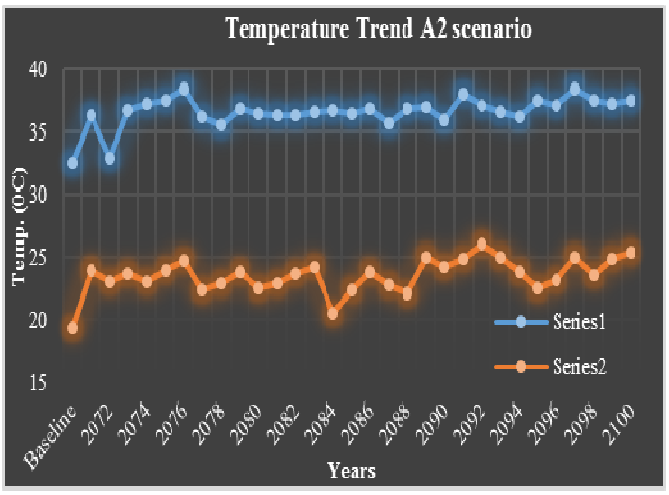
Roni= n^{th} day (from beginning of month) observed rainfall of i^{th} month under base line period.

Rpi avg= 30 years average of monthly sum of rainfall of i^{th} month under projected condition.

Roi avg= 30 year average of monthly sum of actual observed rainfall of i^{th} month under baseline period.

3. RESULT AND DISCUSSION

Projected climatethe variation in Tmax, Tmin and rainfallduring projected period are depicted in Figure 2.



(Series 1- Maximum Temperature Series 2 Minimum Temperature)

Fig. 2. A_2 scenario temperature

Results showed that the rate of increasing trend wasfound higher for Tmin as compared to Tmax. Results showed that there will be mean rise of maximum and minimum temperature to the tune of 13 and 22 %, respectively against the base line periods 1961-90 (Fig.2). Average annual maximum temperature for the projected period is likely to be higher than the base period temperature by 4.3 ^{0}C with maximum value of 39.9 ^{0}C in the projected year 2077 and with minimum value of 33.0 ^{0}C in the projected year 2072. Similarly, the average annual minimum temperature for the projected period is likely to be rise by 4.29 ^{0}C with maximum value of 25.1 ^{0}C in the projected year 2089 and with minimum value of 22.2 ^{0}C in the projected year 2088. The average rise during 2070-2100 was 4.3 ^{0}C in both the maximum and minimum temperature as compared to their baseline temperatures (32.6 and 19.4 ^{0}C respectively). The rate of rise of Tmax and Tmin was 0.003 and 0.002 ^{0}C/year. Similar kind of temperature variation trend was found by (Kumar G. et al) for Central Gujarat and New Delhi, respectively using PRECIS model under A_2 scenario.

3.2. Trend of Phenology and Yield attributing Characteristic during Projected Period

Trends of Potato tuber yield, yield attributingcharacters and phonological variation duringprojected period

3.2.1.Potato Tuber Yield

Yield is at Harvest time Simulatedand results as following.

Figure 3 Shows Totalyearly production during projected period. The mean tuber yield during baseline and A_2 scenarios (2071-2100) are presented in Fig.4 And The Projected mean yield is 17486 (kg/ha). Yield in baseline and A_2 scenario in both the cultivar Result showed that the mean yield under baseline period 26940 (kg/ha).

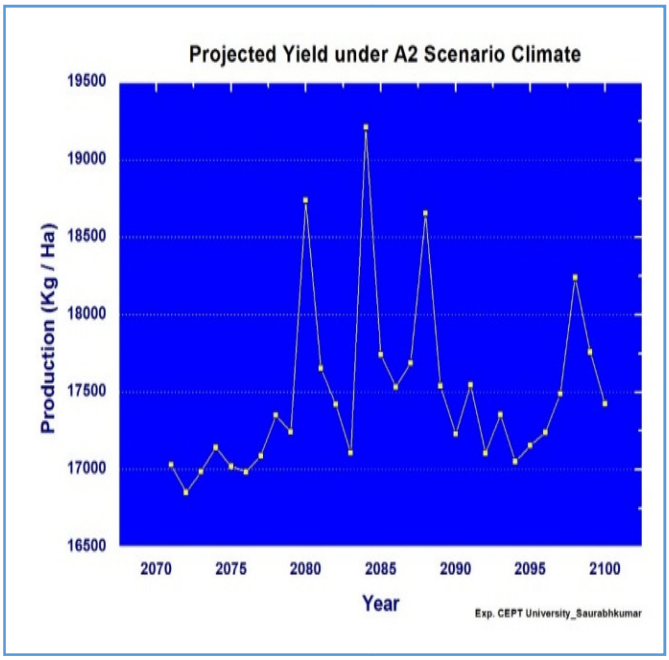


Fig. 3. The projected yield in A_2 scenario (simulated)

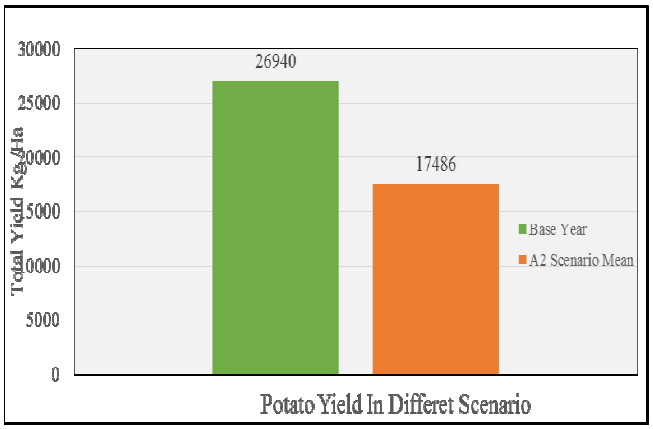


Fig. 4. Maximum yield of Potato base year and Mean yield of potato underA2 scenario of experimental Cultivator

Nearly, Mean of projected period 35.09 % yield reduction as compared to baseline was noted respectively mention in fig4

3.2.2. Phenology

Maximum LAI (Leaf Area Index)

Specific leaf area is calculated as area leaves per unit dry weight of leaves at different stages For Baseline study and For projected Scenario is calculated By DSSAT Model.The Maximum LAI projected period presented in Figure 5.

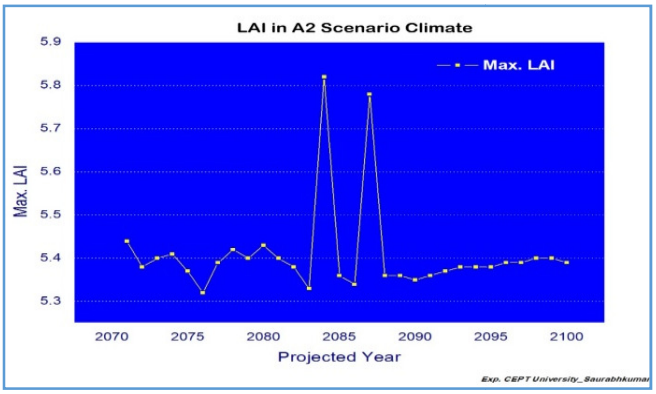


Fig. 5. Maximum Leaf area index under A_2 scenario

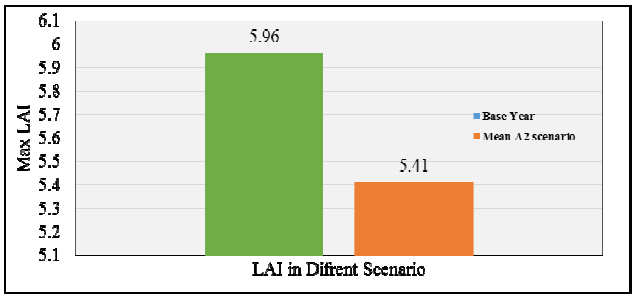


Fig. 6. Leaf area index Reduction from Baseline to Projected Scenario

About9.23 % Mean LAI reduction was noted respectively. This shows that higher LAI reduction will be noted during A_2 scenario From Baseline.

3.2.3 Yield Attributing Character-Total Biomass

The biomass is the plants tops, roots and other vegetative material has considered as biomass in this parameter of study. If the vegetative growth is more dens and bulky it results in higher yield. The observed Biomass is considered from sample size scale up to hector level.

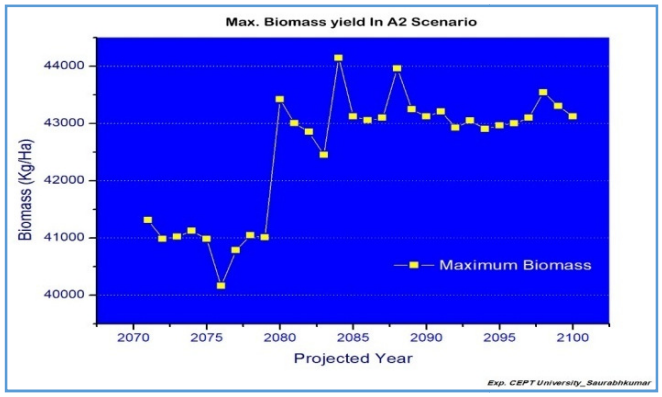


Fig. 7. Maximum yield of Biomass under A_2 scenario

The biomass yield results were found more or less similar as Tuber (potato) yield. Depicted in Figure 7.

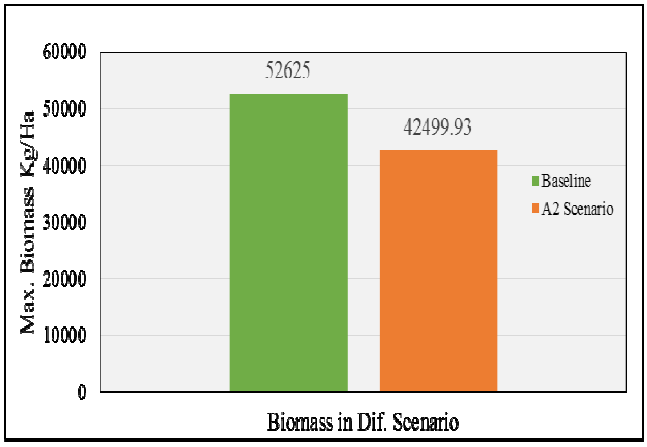


Fig. 8. Maximum yield of Biomass Reduction from Baseline to Projected Scenario

The mean biomass yield under baseline and A_2 scenario Climate shown in Fig. 8The baseline biomass yield was 52625 (kg/ Ha).And Under A_2 Scenario climate Simulated yield is varied between 16 to 24 % reduction the mean Biomass projection is 19% reduction with 42499 (kg/ Ha) results.

3.3Adaptation measures

From Secondary review and analysis Chang in Dateof sowing may get good result for various Crop. However Potato is Winter Crop In study Region certain meteorological parameterlikeSolar Radiation it varies with the DateAt maturity stage tuber may get affected During the Late Maturity stage. Secondary option is to provide the proper amount of required fertilizer at critical stage of plant e.g. *Sprout elongation and tuber bulking*which may provide good yield.

4. CONCLUSION

In Kufri Pukhraj potato cultivator mean 35.09 % yield reduction was noted as compared to baseline in respectively under projected period.

As the LAI (maximum leaf area index) and Biomass of potato crop (leaf stalk and stem) is decline by 9.23 % and 19.09% respectively simultaneously Potato yield is decline by the 35.09%.

5. ACKNOWLEDGEMENT

The Authors highly acknowledge technical support received from Department of Agricultural Meteorology, Anand Agriculture University, Anand. For the present research.

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