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Impact of projected climate change on wheat and maize in middle Gujarat agro-climatic zone

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ABSTRACT

The impact of projected climate change on wheat and maize (kharif and rabi) have been studied for Anand and Dahod districts of Gujarat state using PRECIS output of A2 and base line data. Yield simulation study was performed by InfoCrop model. The field experiment data on wheat collected at Anand during 2005-2009 and for maize collected at Dahod during 2004-07 respectively were used for calibration and validation of the model. The simulated yield over projected period (2071-2100) showed that nearly 38 to 43 % yield reduction was noted in both the cultivars as compared to their base yield. However, the yield reduction was lower under late sown condition (30th Nov.) and higher in early sown (1st Nov.).

In case of maize cultivars the percent reduction in yield during *kharif* season was higher in 15th July sowing as compared to 1st July sowing. Under normal (1st July) sowing nearly 40 % reduction in yield was simulated by model during projected period. During rabi season the yield reduction was less which clearly suggested that *rabi* sowing of maize found most beneficial under climate change as compared to kharif sowing.

Key words: PRECIS, simulation, InfoCrop, Climate change

Crop production is largely affected biophysically by meteorological variables, including rising temperature, changing precipitation regimes and increased atmospheric carbon dioxide level etc. The biophysical effects of climate change on agricultural production will be positive in some agricultural systems and regions and negative in others and these effects will vary through time (Parry *et. al*., 2004).

Various crop models are being used for optimizing natural resources to assess the impact of future potential climate on crop production (Rosenzwieg and Iglesias, 1998; Rao and Sinha, 1994; Rosenzwieg and Parry, 1994). In this paper an attempt has been made to evaluate the likely impact of climate change on wheat and maize yields of middle Gujarat agro-climatic zone of Gujarat under different realistic hypothetical situations and for this, user friendly version of InfoCrop (Aggarwal *et al*, 2004), a generic simulation model developed for tropical condition is used.

MATERIALS AND METHODS

Climate change study

For climate change impact study, weather data for A2 scenario was derived from PRECIS downscaled model output prepared by IITM Pune in a grid size of 0.4 degree. Two periods of 30 years each, one for base line i. e., 1961-1990 (base line period) and another for A2 projected scenario i.e., 2071-2100 (projected scenario) for Anand and Dahod were considered for climate change impact study. There are gross difference between PRECIS base line daily weather data and actual weather data for the same period. Thirty year monthly average of daily weather parameters of base line data was subtracted from corresponding projected A2 scenario data and the difference obtained were used for computing weather data for projected period using actual observed data. In case of rainfall percentage difference on monthly sum of 30 years average data, between projected output and base line output were used as correction factor.

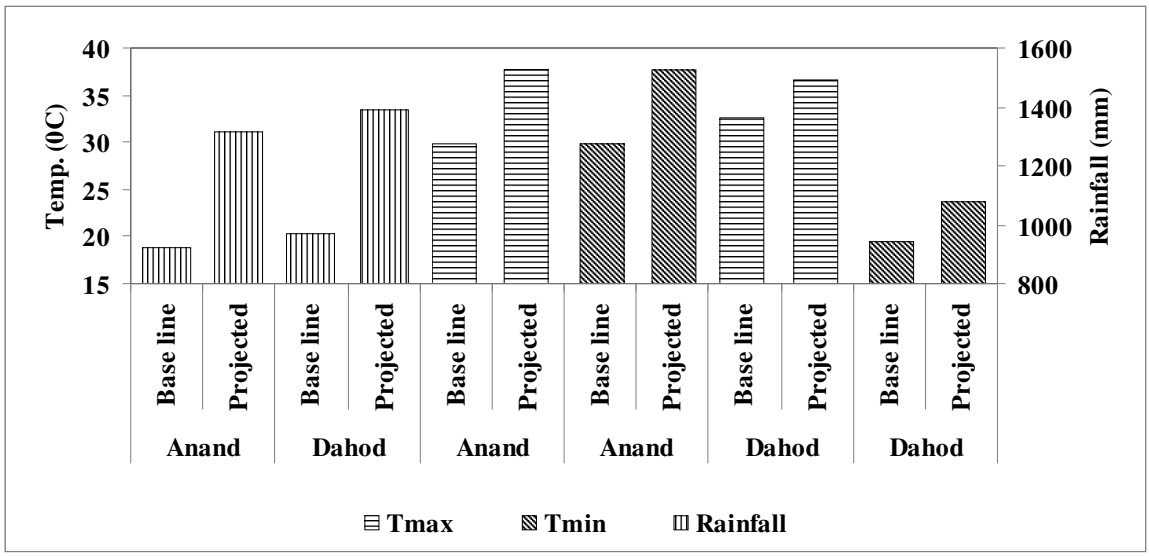

Fig. 1: Climate change projections over Base line at Anand and Dahod

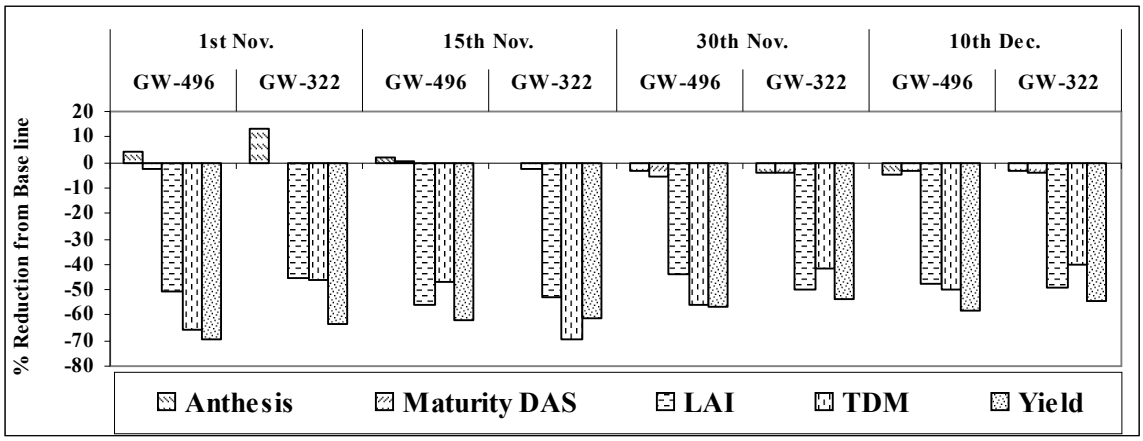

Fig. 2: Impact of climate change on wheat at Anand region

Data requirement for InfoCrop model

For calibration and validation of the InfoCrop model, observed weather data were obtained from Agro. meteorological observatory, Dept. of Agril. Meteorology, AAU, Anand and Main Maize Research Station, Godhra. Top layer soil data file of similar texture were modified in Master file using actual soil data of respective experimental site. The field experimental data on wheat cv. GW-496 and GW-322 collected during 2005-07 and 2006-09 at Anand were used for calibration of InfoCrop model. Similarly the field experiment data on maize for cv. GS-2 and GM-6 collected during 2005-2007 and 2006 to 2009 respectively at Main Maize Research Station, AAU, Godhra were used for calibration and validation of InfoCrop model for maize crop. These validated models were used to simulate the wheat yield at Anand and maize yield at Dahod during projected climate change scenario (2070-2100).

RESULTS AND DISCUSSION

Projected climate over base line

The climatic base line (1960-90) and projected climate (2071-2100) under A2 scenario have been compared for Anand and Dahod and presented in Fig. 1. The results of climate change projections showed that Anand will receive 13 % higher rainfall as of base line rainfall (919 mm). There will be rise in maximum and minimum temperature of 5.08 and 3.57 ^{0}C under projected period of base line of 29.8 and 19.07 ^{0}C respectively. Dahod will receive 40 % higher rainfall as base line rainfall (972 mm). The maximum and minimum temperature will be higher by 3.97 and 4.29 ^{0}C as of base line of 32.6 and 19.4 ^{0}C respectively.

The impact of climate change during the projected period (2071-2100) on wheat and maize were simulated

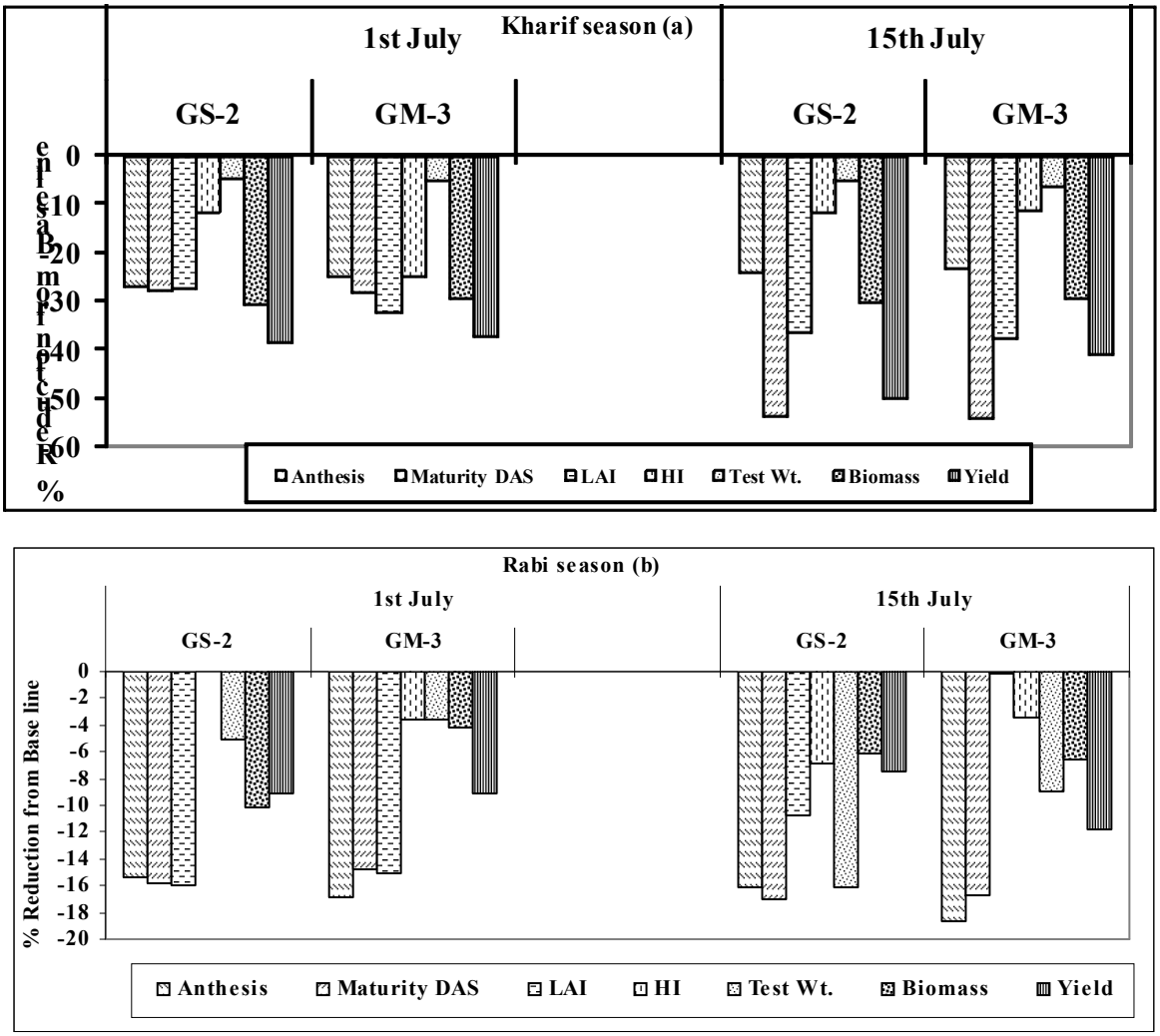

Fig. 3: Impact of climate change on (a) *kharif* and (b) *rabi* maize at Dhaod

using InfoCrop model for growth, development and yield and compared with base line (1960-90) simulated results.

Impact on wheat

The climate change impact on wheat cv. GW-496 and GW-322 depicted in Fig. 2 for Anand showed that maturity and anthesis days will not change much in both the cultivars under different dates of sowing. Date of anthesis was extended due to cooling at the time of flowering i.e. 1st and 3rd week of January in 1st and 15th November sowing of wheat. Under later sowing (3rd and 4th dates of sowing) cooling period was coincided with reproductive stage and found beneficial for obtaining higher yield. Higher reduction in LAI and total dry matter was observed during 1st and 15th November sowing as compared to later sowing under both the cultivars. As far as yield is concerned GW-322 was found superior during 30th and 10th December sowing as compared to cv. GW-496. This might be due to shifting of winter season and hence 1st and 15th November sowing showed greater yield reduction due to higher temperature in early part of season. Shifting of sowing with appropriate cultivar was found beneficial under projected climate change.

Impact on maize

The impact on maize for Dahod district under *kharif* and *rabi* season for cv. GS-2 and GM-3 is depicted in Fig. 3 and 4. The percent reduction in yield, biomass, anthesis, maturity, LAI, harvest index and test weight were greater during 15th July sowing as compared to 1st July sowing in both the cultivars. Under late sowing condition (15th July) growing season was drastically reduced and negatively affect on final yield. Under optimum (1st July) sowing both the cultivars gave 40 % reduction in yield as compared to their base line yield.

Similarly for *rabi* sowing of maize the percent reduction was found higher under 15th November sowing as compared to 1st November sowing. Both the cultivars were found suitable under 1st November sowing for higher yield. The per cent reduction in crop growth, development and yield was found lower under *rabi* season as compared to kharif season. Vast differences in percent reduction in yield of maize were noticed under *kharif-rabi* sowing. The *kharif-rabi* sowing and its impact on yield clearly suggested that rabi sowing of maize found most beneficial under projected climate change as compared to *kharif* sowing.

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