Wheat productivity at various N-levels and future predictions under changing climate

Muhammad Rizwan Shahid[1], Wajid Ishaque[2], Muhammad Sanaullah[1], Abdul Wakeel[1*]
[1]Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan
[2]Soil and Environmental Sciences Division, Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Pakistan
E-mail: abdul.wakeel@uaf.edu.pk

Abstract

Food security and sustainability need appropriate nutrient management and timely sowing of wheat crop under changing climate. Field trials were conducted to assess nutrient and water productivity for wheat in irrigated semi-arid conditions in Pakistan. The treatments include six sowing dates (20, 30 October, 10, 20, 30 November and 10th December) with five nitrogen levels i.e. 0, 60, 120, 180 and 240 kg ha^{-1}. CSM-CERES-Wheat model were used for climate change impact-assessment and the results showed that N-levels have not much significant effect but date of sowing show more significant results on wheat yield. Model predicts that the date of sowing 30th of November with 180 kg N ha^{-1} performs better than other dates of sowing under these changing climate scenarios by the years 2030, 2050 and 2090.

Keywords: sowing time, climate change, N-fertilizer levels, rcps, csm-ceres-wheat

1. Introduction

Wheat (*Triticum aestivum* L.) as a major agronomic crop influences has the maximum acreage in Pakistan as it is a staple food of huge population in the country and in some neighbouring countries as well. The average yield of wheat is less than the potential yield due to various factors including improper sowing time, seasonal fluctuations in temperature, irrigation management and application of fertilizer at proper time etc. Changing climatic condition is shifting the sowing the harvesting time of the crops, so is the fertilizer application rate and timing. To sustain the food security of a major population of the country, it is very crucial to devise recommendations for wheat production in future keeping in view the rise in temperature in coming 30 to 50 years. This study was planned to predict the N management in wheat crop production using appropriate model.

2. Methodology

Field experiemnts were conducted to evaluate the effects of different N-levels and sowing dates on wheat productivity. CSM-CERES-Wheat model was callibrated and than evaluated by using the data collected during the experiments. Model efficacy was checked by computing different statstical indicies (R^2, d, RMSE).

$$\mathrm{RMSE} = \left[\sum_{i=1}^{n} \frac{(P_i - O_i)^2}{n}\right]^{0.5}$$

$$\mathrm{d} = 1 - \left[\frac{\sum_{i=1}^{n}(P_i - O_i)^2}{\sum_{i=1}^{n}\left(|p'_i| + |o'_i|\right)^2}\right]$$

3. Results and Discussion

Biological and grain yield were increased up to sowing date 10th of November and then a decreasing trend was started led to 10th of December. Significant ($p \geq 0.05$) interaction was observed between DOS and N-levels. DOS and N-levels interactive affect showed higher biological and grain yield at

180 and 240 kg N ha^{-1} respectively, when crop was sown on 10th of November. Model predicts that the date of sowing 30th of November with 180 kg N ha^{-1} performs better than other dates of sowing under these changing climate scenarios by the years 2030, 2050 and 2090 as shown in figure 1 and 2.

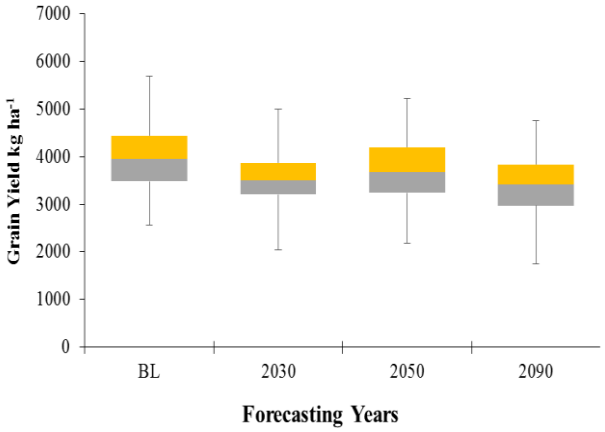

Figure 1. Grain yield simulated by CSM-CERES-wheat model under RCP 4.5 as compared to baseline (BL) using mean ensemble weather data for different forecasting years (2030, 2050 and 2090) with 180 kg N ha^{-1} at sowing date 30th November

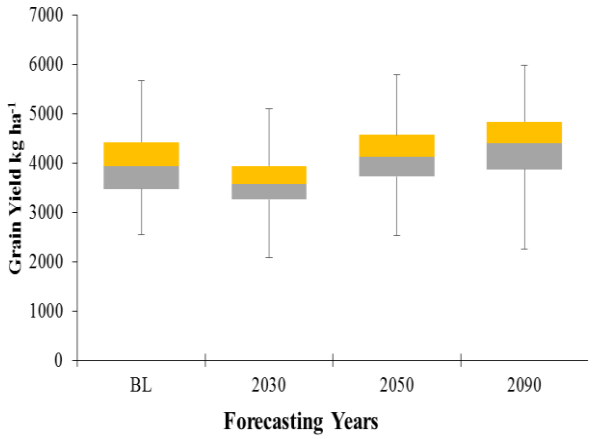

Figure 2. Grain yield simulated by CSM-CERES-wheat model under RCP 8.5 as compared to baseline (BL) using mean ensemble weather data for different forecasting years (2030, 2050 and 2090) with 180 kg N ha^{-1} at sowing date 30th November

4. Conclusion

CSM-CERES-Wheat model predicts that the date of sowing 30th November with 180 kg N ha^{-1} performs better than other dates of sowing under changing climate scenarios (RCPs) by the years 2030, 2050 and 2090.