Is Rainfed Wheat productivity vulnerable to climate change?

Muhammad Aqeel Aslam[1,3], Mukhtar Ahmed[1,3], Fayyaz-ul-Hassan[1], Riffat Hayat[2], Claudio O. Stöckle[3]

[1]Department of Agronomy, PMAS Arid Agriculture University Rawalpindi-46300 Pakistan

[2]Department of Soil Science and SWC, PMAS Arid Agriculture University Rawalpindi-46300 Pakistan

[3]Biological system Engineering, Washington State University Pullman, WA 99164-6120

Abstract

Global climate change continues to be a major concern in this century, and temperature is the main signal of the change at both global and regional scales. Wheat yield might be adversely effected by increase in seasonal temperature. The changing climate is already adversely effecting wheat yield in rainfed areas of Pakistan. A field experiment was carried out at three varying climatic conditions (low temperature/high rainfall, medium temperature/rainfall and high temperature/low rainfall respectively) of Pothwar, Pakistan. For early sowing dates higher wheat yield recorded compared to later sowing dates. Decline in grain yield recorded (3.8 to 1.25 t ha^{-1}) at all locations with increase in seasonal temperature. Harvest index also reduced (0.39 to 0.22) due to increase in seasonal temperature but this reduction was not very high. Days to maturity reduced (168 to 125) greatly with the increase in seasonal temperature.

Introduction

Global climate change continues to be a major concern in this century, with negative impacts in hot and dry areas (e.g. Parry et al., 2004. Wheat yield might be adversely effected by increase in seasonal temperature. A warmer climate will accelerate the crop phenology affecting crop yield (e.g. Ahmed, et al. 2012).

Methodology

An experiment with different sowing dates was conducted aimed at producing different seasonal temperature scenarios including three varying climatic conditions (low, medium and high temperature respectively) of Pothwar, Pakistan. The objective of the experiment was to examine how different wheat genotypes respond to varying climatic locations across Pakistan. The field experiment was laid out using RCBD four way factorial design. The treatments were four sowing times (21 Oct, 11 Nov, 1st Dec and 21 Dec) creating different seasonal temperature conditions, three climatic locations (Islamabad, Koont and Talagang), five wheat genotypes (NARC-2009, AUR-809, Pak-13, Chakwal-50 and Dhurabi) and the experiment was repeated for two years (2013-14 and 2014-15).

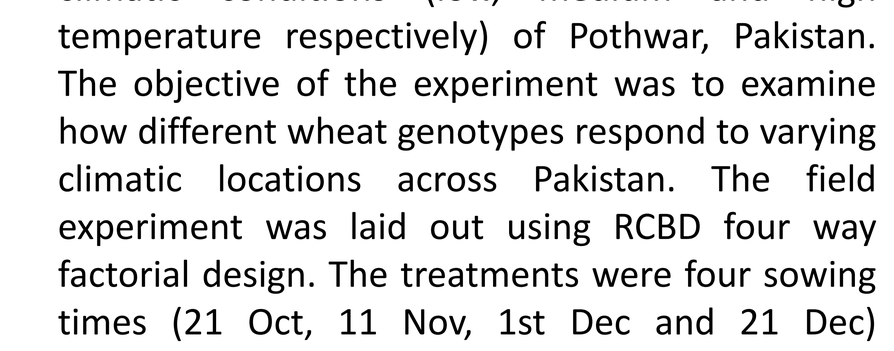

Fig. 1. Wheat grain yield for four sowing dates under three varying climatic locations during two years

Results

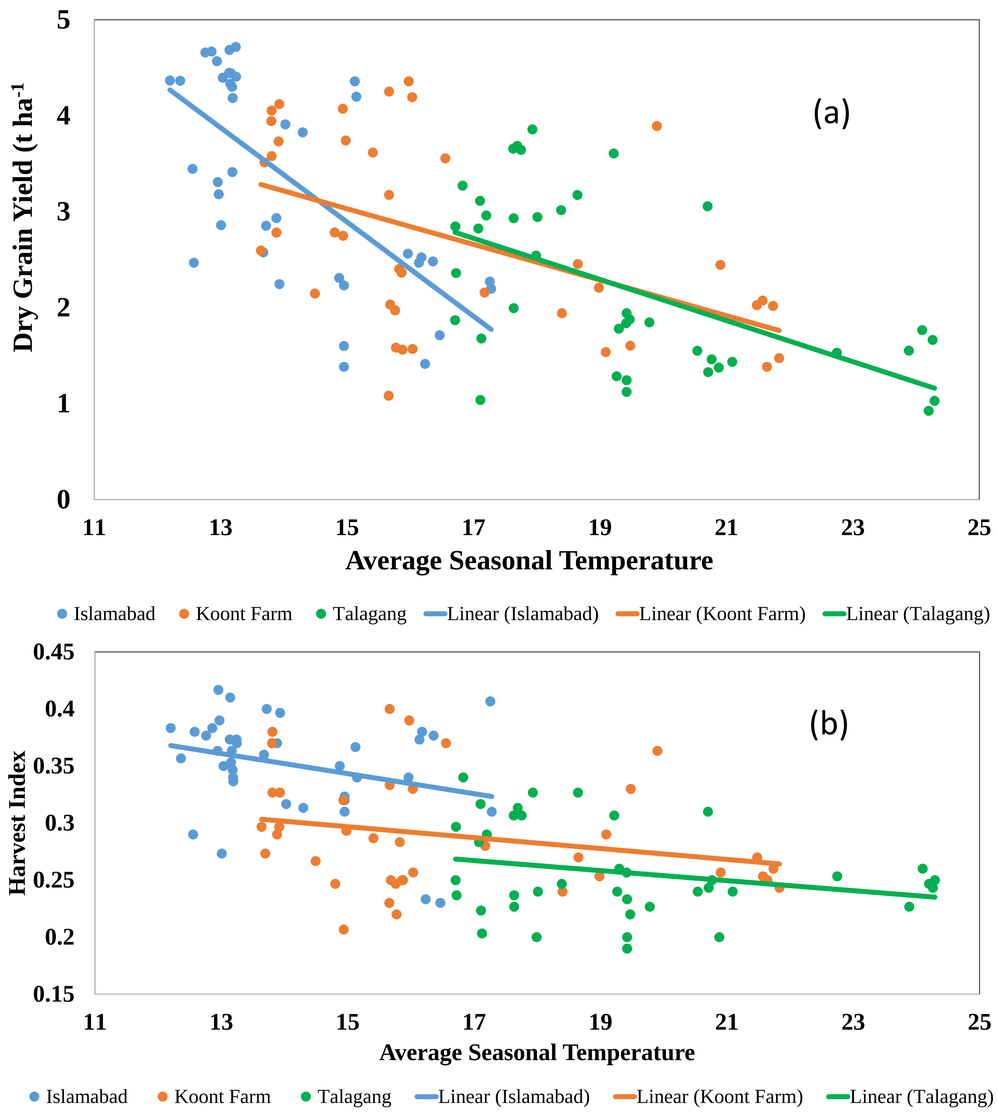

Fig. 2. Wheat dry grain yield and Harvest Index at Islamabad, Koont and Talagang under four sowing dates during both years under increasing temperature

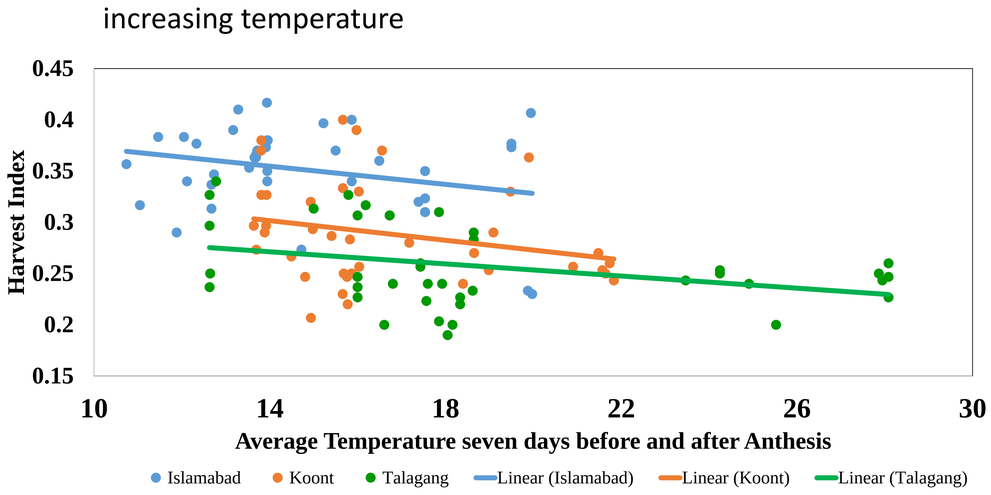

Fig. 3. Trend line for wheat harvest index under increasing average anthesis onset temperature for four sowing dates under three varying climatic locations during two years

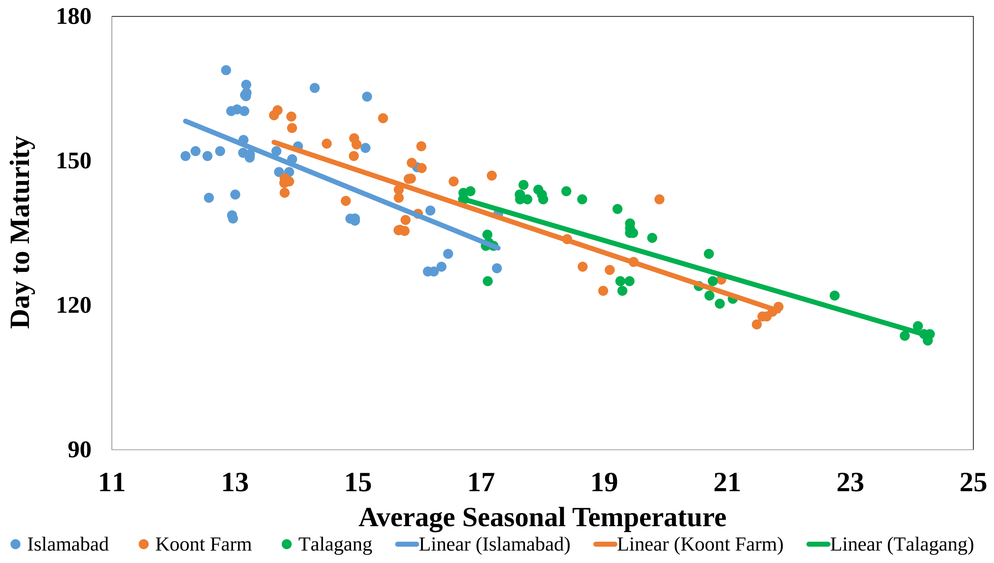

Fig. 4. Days to maturity at Islamabad, Koont and Talagang under four sowing dates during both years under increasing temperature

Results

- ✓ Due to variation in seasonal as well as flowering temperatures around flowering grain yield varied significantly under all the varying climatic locations (Fig. 1).
- ✓ Higher grain yield recorded at Islamabad compared to all other locations but with the increment in seasonal temperature yield was also reduced (Fig. 2). Koont and Talagang captured lower and decreasing grain yield due to higher seasonal temperature. The harvest index did not changed largely among all the locations under varying seasonal climate.
- ✓ Harvest index decreased at all locations as seasonal and around flowering temperature increased (Fig 2 and 3).
- ✓ Harvest index were higher at Islamabad, intermediate at Koont and lower at Talagang.
- ✓ With the increase in temperature the number of days to maturity were reduced at all locations resulting in lower grain yield (Fig 4).

Conclusion

Wheat growth and development is highly vulnerable to temperature. A shift from optimum sowing time to later sowing can significantly reduce wheat yield due to increased seasonal temperature. Therefore, the ability of crop models to properly account for changes in phenology in response to temperature is vital for prediction of yield response to global warming.

Acknowledgements

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