FOOD SECURITY AND CLIMATE CHANGE

With wheat being the third most commonly grown crop in the world for the past 30 years, studies that focus on wheat response to climate change are key players in eliminating food insecurity. This project investigates how rising atmospheric carbon dioxide concentration and variability in precipitation affect yield and physiological performance of rainfed California winter wheat in a 23-year field experiment. Isotopic signatures of archived wheat are proxies for changes in stomatal conductance, a water stress indicator. The analyses indicate wheat yields have not been affected by abiotic pressures (i.e. variable seasonal precipitation or atmospheric CO2 concentration) suggesting changes in water use efficiency are tolerated by current wheat varieties. Wheat’s resilience to unfavorable climatic factors indicates that the threshold drought limits for yield decline were not met within the experimental period. This phenomenon is confirmed by the lack of separation in isotopic signatures between normal and dry years. Nitrogen input had the largest effect on yield in this system.

YIELD UNAFFECTED BY ABIOTIC FACTORS

Drought Conditions and Rising CO2

No relationship between drought, CO2, and yield

PDSI is a drought severity index that estimates available soil water.

METHODS

Agronomic data was accessed through the UC Davis Russell Ranch Database on the Century Experiment, conducted in Yolo County, beginning in 1993. Climate data was collected from CIMIS, Foa1, and NOAA1. Isotopic analysis was preformed at the Stable Isotope Facility at UC Davis. Each year there were a total of 18 plots under two year soil treatments, rainfed only. In a given year half the plots grew wheat and the other half were fallow or grew legume cover crops. The treatments are as follows: Mineral Fertilizer-received synthetic fertilizers, pesticide applications, and a fallow alternate year. Cover Cropped received no fertilizer, no pesticide, and a legume cover crop was planted the alternate year. Control- received no fertilizer, no pesticide, and a fallow alternate year. Winter wheat cultivars changed from Serra Wheat planted in 1994-2003, Summit Wheat planted 2004-2006, and Cal Rojo Wheat planted 2008-present. Mixed linear models were used to assign variation to factors and ANOVA test results determined significance of those factors.

REFERENCES

4. Environmental Studies Program and Department of Geography, University of Oregon, Eugene

YIELD UNAFFECTED BY WATER USE EFFICIENCY

Carbon-13 discrimination in the leaf (D13C) is a proxy for drought stress because under normal conditions carbon assimilation preferentially fixes light carbon isotopes. However when a plant is under water stress, stomata close to reduce transpiration and maintain cell turgor pressure. Consequently, light carbon dioxide molecules are not available and less discrimination occurs during assimilation. Therefore, a smaller D13C value indicates more stress.

Diffusion accounts for 4% of heavy isotope discrimination during photosynthesis. Carbon assimilation accounts for 23% of discrimination.

Isotope signatures do not indicate drought stress

Overlapping D13C of PDSI categories indicate that moderate drought does not produce physiological signs of stress in winter wheat.

Water use efficiency (WUE) is unrelated to yield

WUE is the amount of carbon assimilated per amount of water transpired, and it is directly related to D13C. Lower WUE values are expected to have lower yields. The expected trend is not upheld in this dataset.

NITROGEN FERTILIZATION INCREASES YIELDS

Mineral fertilizer and cover crops treatments increase yield over time and new cultivars do not increase yields.