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A Comparison of Electron Transport Rate, Photosynthetically Active Radiation, Light-Adapted Fluorescence, and Dark-Adapted Fluorescence Between *Stipa pulchra* and *Pennisetium setaceum*

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Abstract

The purpose of this investigation was to provide an explanation into how the invasive species *Pennisetium setaceum*, Fountain Grass, is able to outcompete the native California grassland species *Stipa pulchra*, Purple Needle Grass. We used a light adapted and a dark adapted fluorometer to measure the photosynthetic radiation (PAR), leaf temperature, alpha (α), light adapted fluorescence (Fv'/Fm'), dark adapted fluorescence (Fv/Fm), and the electron transport rate (ETR) on young Fountain Grass and Purple Needlegrass. After collecting and analyzing the data, we concluded that the dark adapted fluorescence (Fv/Fm) was the only statistically significant measurement where the Fv/Fm of *S. pulchra* is higher than that of *P. setaceum* which suggests that *S. pulchra*'s quantum yield of photosystem II is higher and is therefore more efficient. With this result, we are able to state that Fv/Fm is not the reason why Fountain Grass outcompetes Purple Needlegrass.

Introduction

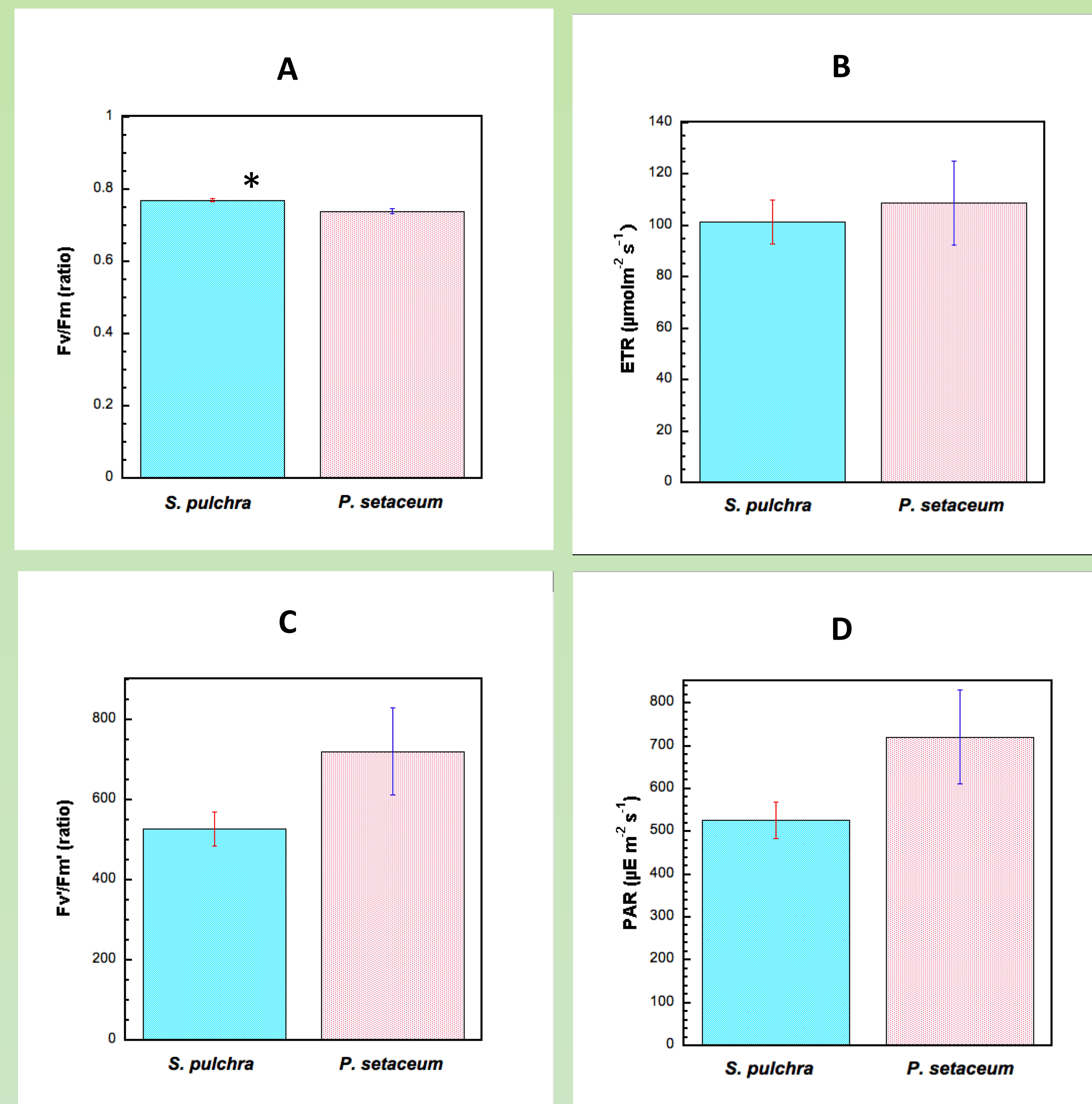
It is fairly well known that a change in climate has ravaged southern California in the form of prolonged drought over the past several years. Many native plants have been impacted by the changes in their ecosystem, which they were suitably adapted for, until recently. In addition to drought, some native California species are being threatened to the point of extinction by invasive species. The California central valley grasslands, comprised of many perennial grasses including *Stipa pulchra*, is classified as critical/endangered by the World Wildlife Fund (worldwildlife.org). *Stipa pulchra*, more commonly known as Purple Needlegrass, is disappearing from the local chaparral due to the alien species known as *Pennisetium setaceum*, or Fountain Grass. Fountain grass has been heavily researched as it has invaded the mountains of Hawaii and driven the native grass *Heteropogon contortus* to endangerment¹. The California grasslands is one of the most heavily invaded ecosystems in North America² and Fountain Grass is recognized as a top eight invader³. Both species are perennial monocots that are adapted to survive in dry, hot environments, yet Fountain Grass is wildly outcompeting Purple Needlegrass for space in the California grasslands. Little research has been done on the long term effects of invasion on this landscape, so we hope our research can shed light into the importance and necessity for the study of the interaction of native and invasive species during this critical time of climate change.



Methods

The following values were recorded for each species of grass using the appropriate fluorometer: PAR (Photosynthetically Active Radiation), temperature of the leaf ($^{\circ}C$), Alpha (α), Fv'/Fm' , Fv/Fm , and ETR (Electron Transport Rate). There were two fluorometers used, one that is suitable for measuring Fv'/Fm' , or light adapted fluorescence, and one that is suitable for measuring Fv/Fm , or dark adapted fluorescence. The data was recorded over two consecutive days at times between 2:00 PM and 4:00 PM. On the first collection day, we located ten patches of Fountain Grass and ten patches of Purple Needle Grass and used marking tape to keep track of them for the next day. We numbered each plant one through ten for each species of grass. Two members measured light adapted fluorescence, while the other two attached dark adapting clips that allow a circular area of the leaves to be completely cut off from sunlight. The clips additionally had a small door that opened and closed to place the fluorometer into. The dark adapting clips had to be in place for at least fifteen minutes prior to data collection. Once the light adapted grasses were measured, the other group measured the dark adapted grasses by opening the doors and inserting the appropriate fluorometer. Both sets of data, dark adapted and light adapted fluorescence, were recorded on an excel spreadsheet on site. After completing the first day of data collection, we removed the dark adapting clips and left the marking tape on the grasses. On the second day of data collection we placed new clips onto the grasses and repeated the data measuring process. Data on ETR, PAR, Fv/Fm , and Fv'/Fm' were statistically tested and graphed for Purple Needle Grass vs. Fountain Grass using the KaleidaGraph software.

Results



(A) From the parameters measured, we found a statistically significant difference between the Fv/Fm data for Purple Needle Grass vs Fountain Grass. (B) From the parameters measured, we did not find a statistically significant difference between the ETR data for Purple Needle Grass vs Fountain Grass. (C) From the parameters measured, we did not find a statistically significant difference between the Fv'/Fm' data for Purple Needle Grass vs Fountain Grass. (D) From the parameters measured, we did not find a statistically significant difference between the PAR data for Purple Needle Grass vs Fountain Grass.

Discussion

After interpreting the data, we found that only one parameter proved to be significantly different between *S. pulchra* and *P. setaceum*. When testing the light-adapted parameters, we found that the electron transport rate, ETR, of *P. setaceum* initially seemed to be higher than that of *S. pulchra*; however this data proved not to be statistically significant. We then tested photosynthetically active radiation, PAR, as well as light adapted fluorescence, Fv'/Fm' , and again, *P. setaceum* had higher rates; however, these data sets were also not statistically significant. Additionally, the errors bars appear to be larger for the light-adapted parameters which may be due to the varying light conditions during the days of data collection. The only data set that proved to be statistically significant was collected from the dark-adapted trials which recorded the dark-adapted fluorescence of each plant, Fv/Fm . We found the Fv/Fm of *S. pulchra* to be higher than that of *P. setaceum* thus suggesting that *S. pulchra*'s quantum yield of photosystem II is higher and is therefore more efficient. Using the student's t -test, we are 95% confident that our data has proved that the efficiency of *P. setaceum*'s photosystem II, or Fv/Fm , is not the reason why *P. setaceum* is able to better adapt to the current drought conditions.

Conclusion

Though much of our data was not significant, our observations still tell us that somehow *P. setaceum* has a larger advantage and has become a weedy invasive species in the environment. In all of our fieldwork, we saw big bushy bunches of *P. setaceum* with plenty of pinnacles for dispersing seed. It seemed to be fast growing and quick to overtake plots of land. On the other hand, we never saw any examples of *S. pulchra* larger than a foot across in diameter, and very few had sparse amounts of seed. Through our experiment, our specific methods did not show the means by which *P. setaceum* is prospering more than *S. pulchra*; however we found that the dark adapted fluorescence may not be the reason why *P. setaceum* is thriving. Future experiments could examine the gas exchange between the plants in order to determine whether or not other parameters contribute to *P. setaceum*'s success in the Santa Monica Mountains.

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