Estimating the correlation and importance of load and chemical compositions in the epicuticular wax layer of wheat leaves with function and performance under stress in historic and current CIMMYT cultivars

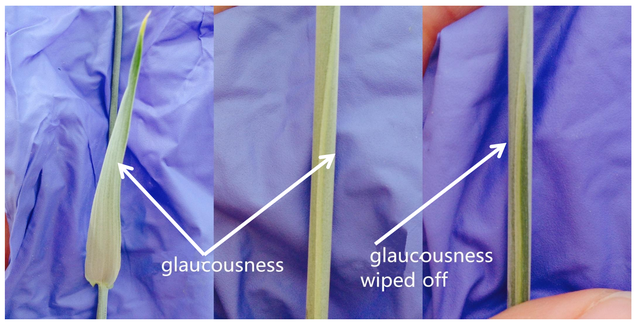
Yalin Li[1], Xiangkun Gu[1], Suchismita Mondal[2], Dirk B. Hays[1]
[1]Department of Soil and Crop Sciences, Texas A&M University
[2]International Center for Wheat and Maize Improvement Center, CIMMYT, Mexico

Abstract

The epicuticular wax layer is known to have a diverse set of functions that protect plants from water loss , irradiation, insects and pathogens. However, some studies have shown that the chemical compositions of this layer can be more important than its thickness[1]. These studies further state that the composition of the wax layer vary at different stages of plant growth. The association between wax load and its chemical compositions, on the other hand, has received little attention. In order to determine possible associations, 60 historic CIMMYT lines with varying amounts of wax load have been selected for study. Wax load and compositions was determined via colorimetric analysis and gas chromatography-mass spectrometry (GC-MS). Greenhouse experiments in 2014 were conducted and in 2015 greenhouse and field experiments are underway. The association will help to elucidate the contributing factors for epicuticular wax layer's function and its unintentional importance in the progress CIMMYT wheat cultivar development program.

Introduction

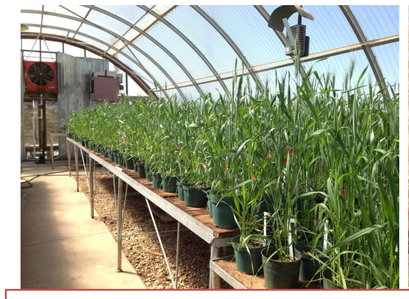
Wheat (Triticum aestivum L.) is one of the three most-produced cereals in the world . Many studies have been done on the response of yield to drought and heat stress. In recent years, heat and drought stress have become more prevalent , further increasing the urgency to develop improved cultivars. Previous studies have focused on the epicuticular wax layer in various plant species. These studies concluded that epicuticular wax plays an important role under high irradiation and water deficit conditions . The wax layer covering the surface of leaves is known as the epicuticular wax layer, while that inside the cutin matrix is known as the intracuticular wax layer[3]. Octacosanol is the major component in the epicuticular wax layer and β-diketone is responsebile for glaucousness, which is a visual observation of epicuticular wax[2]. The association between wax load and chemical composition will help to understand wax functions and optimize the trait in breeding.



Objective

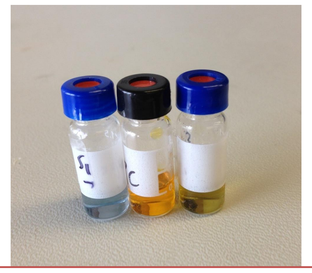
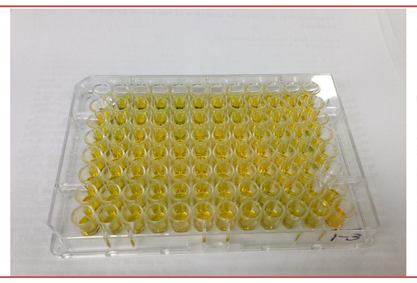
- Estimate the correlation between wax load and chemical compositions in epicuticular wax layer of wheat leaves and its association with the regional adaptation in CIMMYT wheat cultivars

Materials and methods

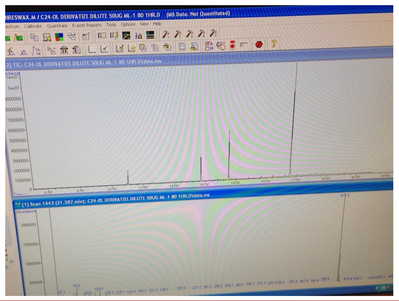


60 CIMMYT cultivars were planted:

- in the greenhouse in 2014 & 2015, with 2 seedlings per pot, 3 replications and arranged in a Randomized Complete Block Design (RCBD);
- in the field (College Station) in 2015.


- Flag leaves from main spike were harvested at flowering and 10 days after pollination (DAP).
- Wax was extracted by chloroform in 30s and each sample is separated into two vials, vacuum dried.
- One vial was for colorimetric analysis[4].
- Wax load was calculated using a standard curve generated by lab previously.

- Another vial with extracted wax was re-dissolved for GC-MS.
- BSTFA and pyridine were added for derivatization.
- Octacosane and heptacosanol were used as internal standard ;
- Lignoceryl alcohol, Hexacosanol, 1-Octacosanol and 1-Triacontanol were used as external stardard.
- Results will be analyzed according to the library.

Research Progress

- Wax content from the materials of greenhouse in 2014 has been analyzed by colorimetric analysis;
- Wax compositions analysis via GC-MS is underway;
- Plant materials from greenhouse and field in 2015 will be harvested in April-June, 2015.

References

[1] Norris R F. Penetration of 2, 4-D in relation to cuticle thickness[J]. American Journal of Botany, 1974: 74-79.
[2] Tulloch A P. Composition of leaf surface waxes of Triticum species: variation with age and tissue[J]. Phytochemistry, 1973, 12(9): 2225-2232.
[3] Mondal S, Mason R E, Huggins T, et al. QTL on wheat (Triticum aestivum L.) chromosomes 1B, 3D and 5A are associated with constitutive production of leaf cuticular wax and may contribute to lower leaf temperatures under heat stress[J]. Euphytica, 2015, 201(1): 123-130.
[4] Ebercon A, Blum A, Jordan W R. A rapid colorimetric method for epicuticular wax contest of sorghum leaves[J]. Crop Science, 1977, 17(1): 179-180.

Acknowledgment

TEXAS A&M AgriLIFE
Teaching • Research • Extension • Service

CIMMYT
International Maize and Wheat Improvement Center