Wheat waxes and wettability

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Introduction

The ease with which a herbicide spray can be retained by, and spread on, a surface is essentially a function of the wettability of the surface. One measure of the wettability of the plant surface is the advancing contact angle. The layer of epicuticular wax that covers the cuticle is one of the most important factors in the behaviour of spray droplets on leaf surfaces (2).

The aim of this work was to determine the contact angle of water on wheat and to examine the structure of the wax deposits in order to identify any relationship between the two.

Materials and method

Wheat *(Triticum aestivum)* was grown to maturity in glasshouses and in a *Grotek* growth cabinet. Leaf samples were taken at both tillering and flowering stages of plant growth. The epicuticular waxes were examined using scanning electron microscopy. Leaf samples were air-dried in a desiccator overnight (3) before being examined.

The wheat leaf was divided into 3 portions; top, middle and base. These portions were cut in half along the axis and one half used for measurements on the adaxial surface and the other used for measurements on the abaxial surface. The leaf portions were attached to glass slides and droplets of distilled water (diameter 2-3 mm) were applied using a micropipette. The contact angle of the droplet was measured using a protractor on a television screen after the image of the droplet was transmitted by a video camera attached to a binocular microscope.

Results

A dense layer of epicuticular wax covered the surface of all samples observed. On the vegetative plant, the wax consisted entirely of platelets on both the abaxial and adaxial surfaces of the leaf.

When the plant reached the flowering stage, a waxy 'bloom' appeared on the stem and on the abaxial surfaces of the flag leaf. When examined in the SEM, the bloom comprised large quantities of filamentous wax. In the middle portion of the abaxial leaf surfaces, a transition zone was apparent, where both filament and plate waxes were observed. Platelet waxes covered the top of the abaxial surface and the entire adaxial surface of a leaf. There were no noticeable differences in wax structure between the plants grown in glasshouses and those grown in the *Grotek* unit.

There were no significant differences in contact angle between leaf surface, position on the leaf or stage of development. The contact angle for the adaxial leaf surface was 139.1 ± 2.5° and for the abaxial surface 136.4 ± 2.8° . It was observed that the adaxial surface was more difficult to wet and was more highly ridged than the abaxial surface.

Discussion

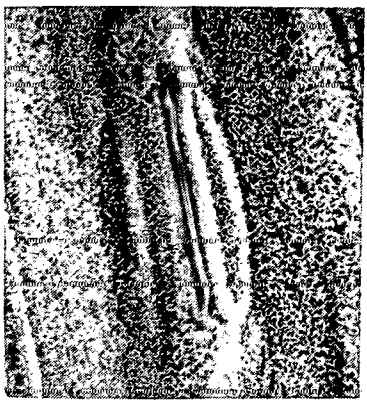
The values of contact angle for wheat surfaces in this study were lower than those found by Troughton and Hall (4), which were generally about 150°, but were well within the range of 118°-152° as reported by Fogg (1). The amount of variation in our data is also comparible to that in these two studies.

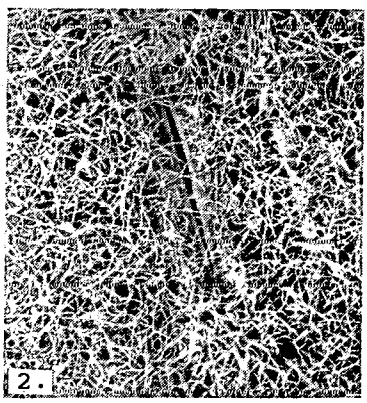
Troughton and Hall (4) reported significant differences between the contact angle on the abaxial and adaxial surfaces of the leaf. In this study a trend towards a higher contact angle for the adaxial surface was observed. This may be due to the effect of the ridges on the surfaces (4) and is reflected in the observation that it was more difficult to place droplets on the adaxial surface.

The major component of the filamentous wax are β-diketones while that of the platelets are alcohols (5). Considering the difference in both form and chemistry of the two wax types, we were surprised to find no significant difference in contact angle with these two waxes. We suggest that it may be that the two wax types each contribute the same amount of 'roughness' to the leaf surface, and thus have the same effect on wettability.

References

1. Fogg, G.E. (1947). Quantitative studies on the wetting of leaves by water. Royal Society of London, Proeedings (Series B). 134: 503-22.
2 Hull, H. M; Davis, D.G. and Stolzenberg, G.E. (1982). Action of adjuvants on plant surfaces. In 'Adjuvants for herbicides'. Weeds Science Society of America.
3. McWhorter, C.G., Paul, R.N. and Barrentine, W.L. (1990). Morphology, development and recrystallization of epicuticular waxes of johnsongrass (Sorghum halepense). Weed Science. 38: 22-33.
4. Troughton, J.H. and Hall, D.M. (1967). Extracuticular wax and contact angle measurement on wheat (Triticum vulgare L.). Australian J. Biol. Sci.20: 509-25.
5. Tulloch, A.P. (1973). Composition of leaf surface waxes of *Triticum* species: variation with age and tissue. Phytochemistry. 12: 2225-32.





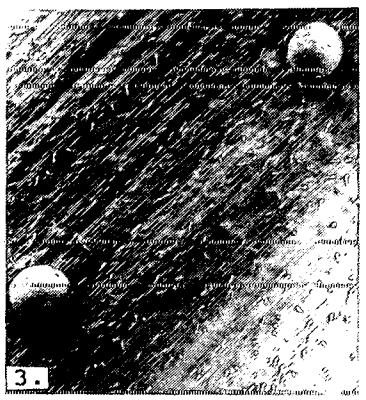


Figure 1 Platelet waxes on vegetative leaf of wheat (x 2000).
Figure 2 Filament waxes on base of abaxial surface of flag leaf (x 2000).
Figure 3 Droplets of water on wheat leaf (prepared cryogenically) (x 50).