MELiSSA

Technical Note

Memorandum of Understanding 19071/05/NL/CP

UNIVERSITEIT GENT

FACULTEIT WETENSCHAPPEN

Technical note: 89.54

Tests results and Evaluation Document

prepared by/*préparé par*	L. Chaerle, J. Decat, D. Van Der Straeten
reference/*réference*	Contract number 19787/06/NL/PA
issue/*édition*	1
revision/*révision*	0
date of issue/*date d'édition*	23oct08
status/*état*	Final
Document type/*type dedocument*	Technical Note
Distribution/*distribution*	

CONFIDENTIAL DOCUMENT

APPROVAL

Title *titre*	issue 1 *issue*	revision 0 *revision*

author *auteur*	date *date*

approved by *approuvé by*	date *date*

CHANGE LOG

reason for change /*raison du changement*	issue/*issue*	revision/*revision*	date/*date*

CHANGE RECORD

Issue: 1 Revision: 0

reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*

Abbreviations

ACC: 1-aminocyclopropane-1-carboxylic cid

CFD: Computational fluid dynamics

Table Of Contents

List of Tables

List of Figures

1. Results of comparative plant stress monitoring tests

1.1. pH and EC control and water use assessment

The measurement of added nitric acid solution, concentrated nutrient solution and water volumes and comparison between treatment and control gives an indication for differences in growth or plant phenotype. However no clear trend emerged from the 2 experiments carried out.

The ACC-treated plants used about double the amount of water during their whole development as compared to the control.

1.2. Ethylene measurement

On-line growth chamber measurements did not indicate accumulation of ethylene, neither in the untreated test-run nor in the 2 experiments when ACC was added to the 'treatment' nutrient solution loop. The level of leakage of the room can be determined from a CO_2 depletion experiment starting with a 1000ppm level. CO_2 level monitoring indicated the reduction from 1000 ppm to ambient level (360 ppm) in about 100 minutes, explaining the absence of ethylene accumulation.

In addition, the air flow of 1 liter per minute used by the PPSystems CO_2 analyzer is routed through the O_2 analyzer and the ethylene analyzer, but not redirected to the chamber, representing an additional leak.

1.3. Air handling system performance

A high airflow is needed to keep the plants at a constant optimal temperature during the light period, given the high radiative heat load of the TL illumination.

The adjustable air flow rate had to be maintained at its nominal design value to match the produced heat of the fluorescent lamp banks, while allowing a temperature differential of 2 degrees to provide enough cooling capacity when outside temperatures (due to weather circumstances) were high.

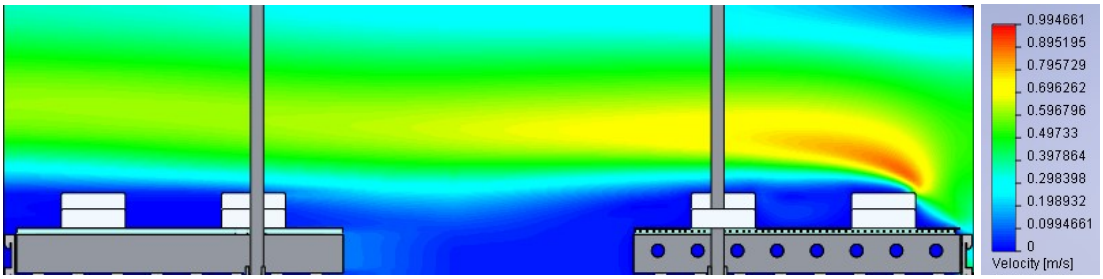

Figure 1: air flow above the plant gullies

At this flow rate, the leaves of the plants closest to the air inflow wall were constantly fluttering. Air flow distribution modeling (using SolidWorks 3D chamber model and FlowWorks CFD module) indicated a peak of flow at this place of nearly 1m/s (Figure 1) which is indeed at the limit of the optimal range.

Further simulation indicated a possible solution consisting of adding a flow barrier along the width and with the same height of the plant gully (Fig. 2 and 3), leading to halving

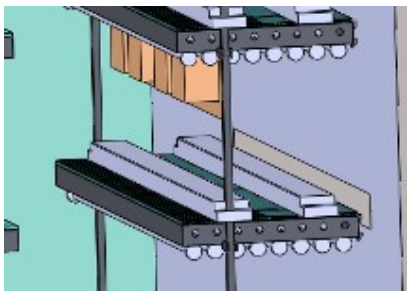

Figure 2: flow modification at the level of the plant gullies

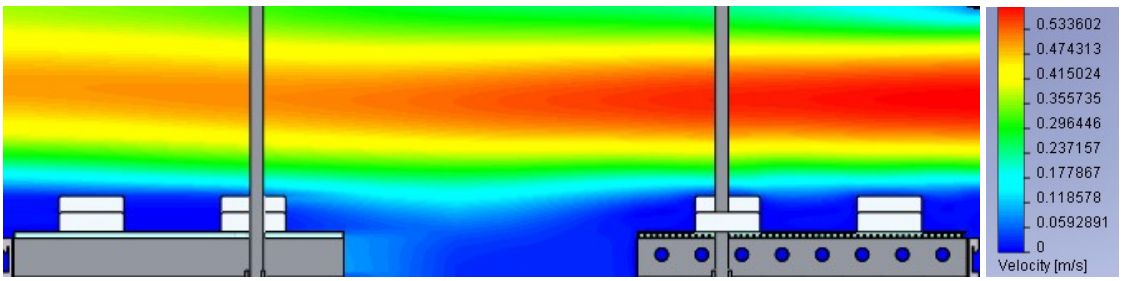

Figure 3: air flow above gullies after modification of air entry

of the maximum observable flow rate. Subsequent post-experimental assessment indicated less leaf flutter, a visual observation that needs to be corroborated by thermal imaging of leaf surface response to the different air flow conditions.

1.4. Plant monitoring

The thermal images of the used dwarf cultivar clearly illustrate the high transpiration of the youngest leaves (dark color indicative of low temperature) during the light period. The plants were grown with a light period of 20h light and 4h dark.

The thermal images in Figure 4 were captured with 16h interval. Hence, pictures of both day (high contrast) and night period (low contrast) are displayed. The red square indicates time of end of ethylene emanation after first treatment with 10 µM ACC (see TN 89.53). Within the images of this square, dark spots indicative of tissue death or necrosis, and associated evaporative cooling through water loss can be discerned. Given the cessation of plant leaf transpiration in the dark period such symptoms can be seen with the highest contrast during this period.

Color and thermal images of the transplanted lettuce plants show higher contrast between the newly emerged leaves and the older leaves (Figures 5 and 7) than mature lettuce plants (Figures 6 and 8).

From Figure 6 and 8 it is also clear that the projected leaf area is larger for the ACC treated plants (Figure 6, left gully treated; Figure 8, right gully treated). Higher ethylene levels are expected to inhibit plant growth. Figure 9 indicates that ACC-treated lettuce is greener, which has been observed consistently. Higher ethylene levels are expected to induce earlier senescence. The reason for this discrepancy is not yet known. The fate of ACC in the nutrient solution is not known and might me metabolized by the microbiota present.

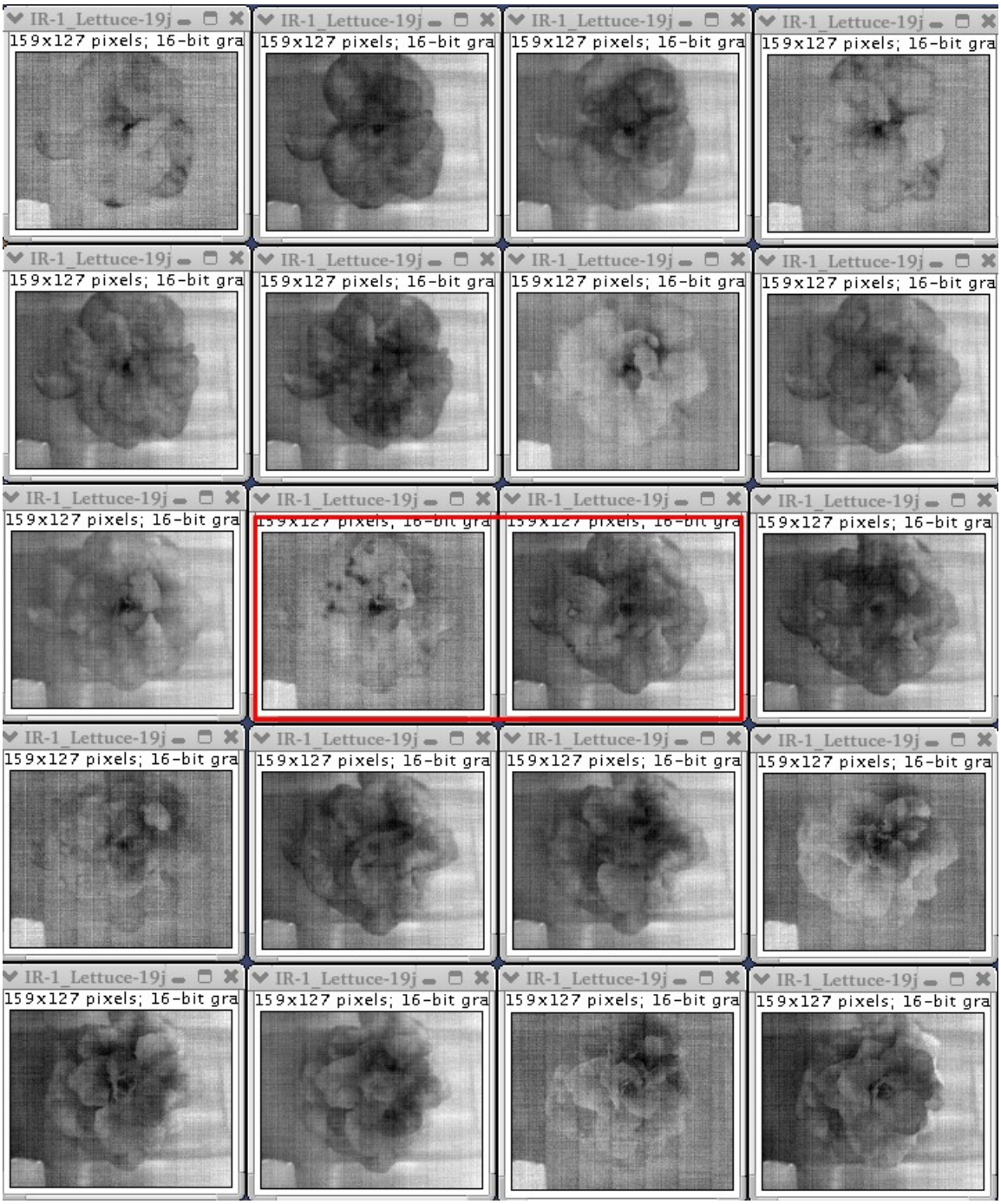

Figure 4: Thermal images of ACC treated lettuce plants.

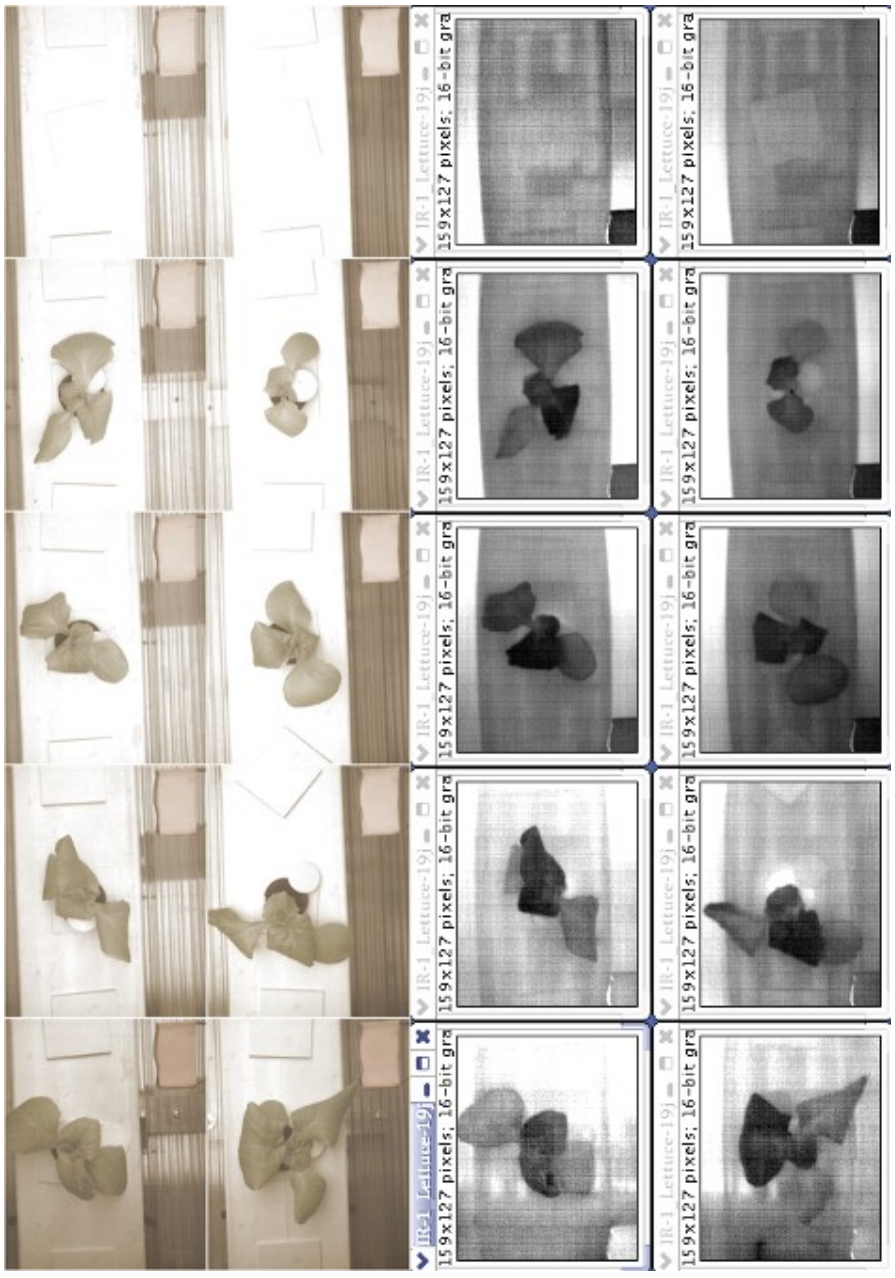

Figure 5: Video and thermal pictures of lettuce in gullies of rack1 after transplantation.

.

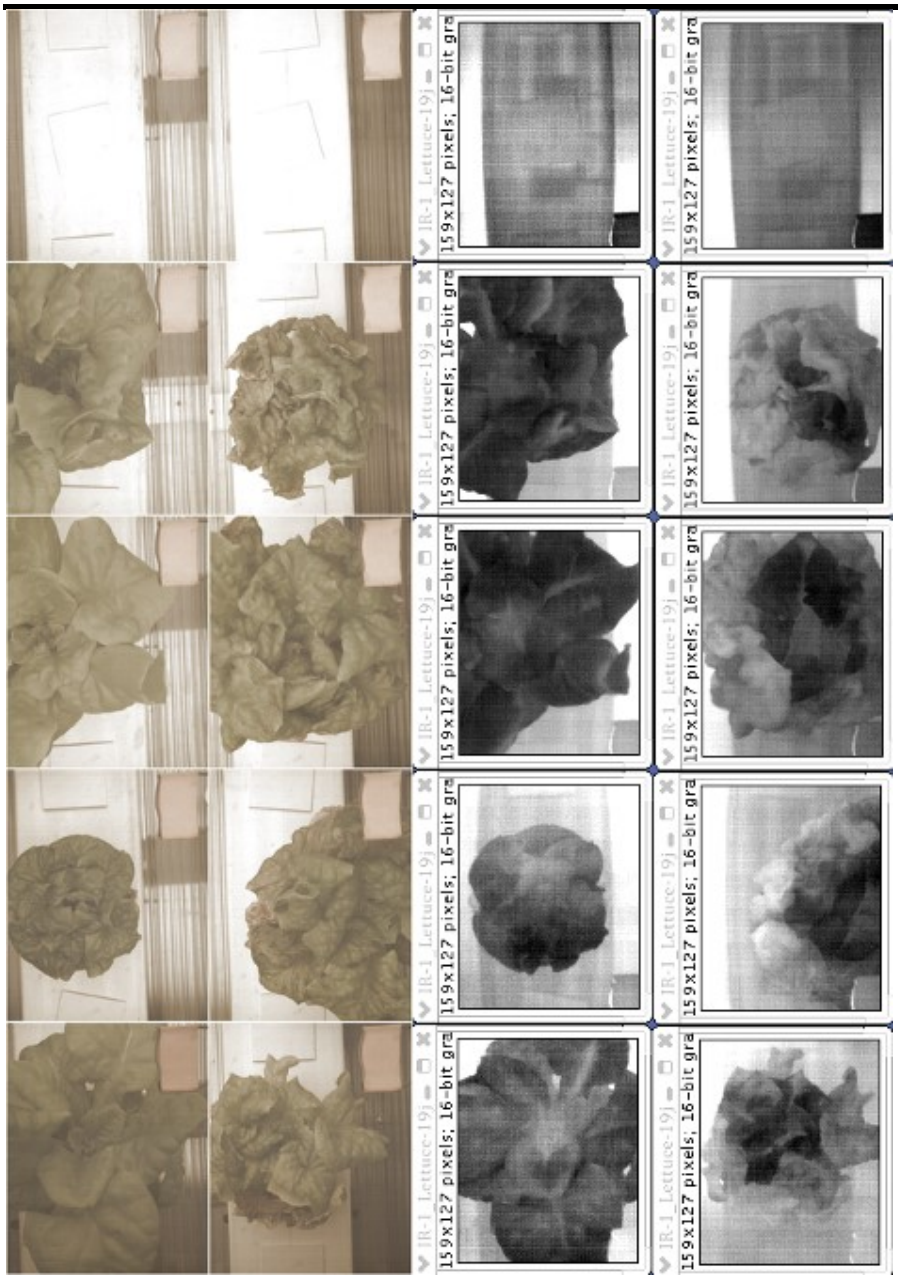

Figure 6: Video and thermal images of mature lettuce heads in gullies of rack1.

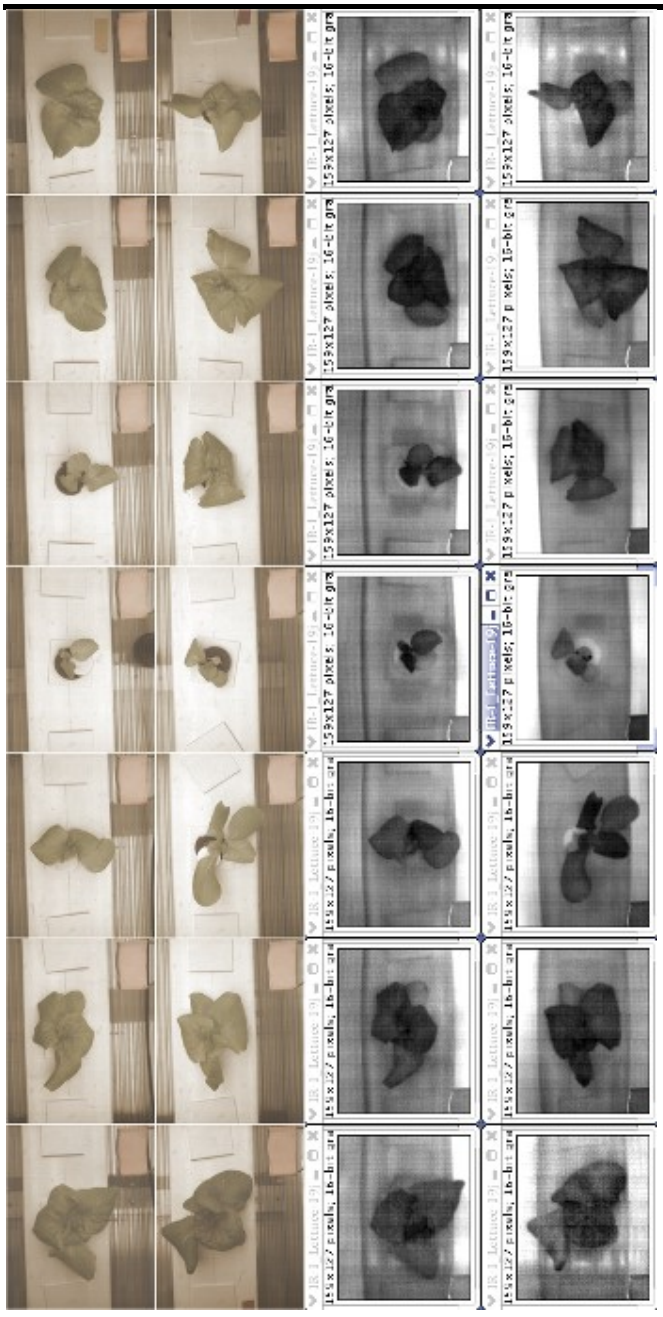

Figure 7: Thermal and visual overview of gullies on rack 6, each with 7 lettuce plants, at transplanting time.

.

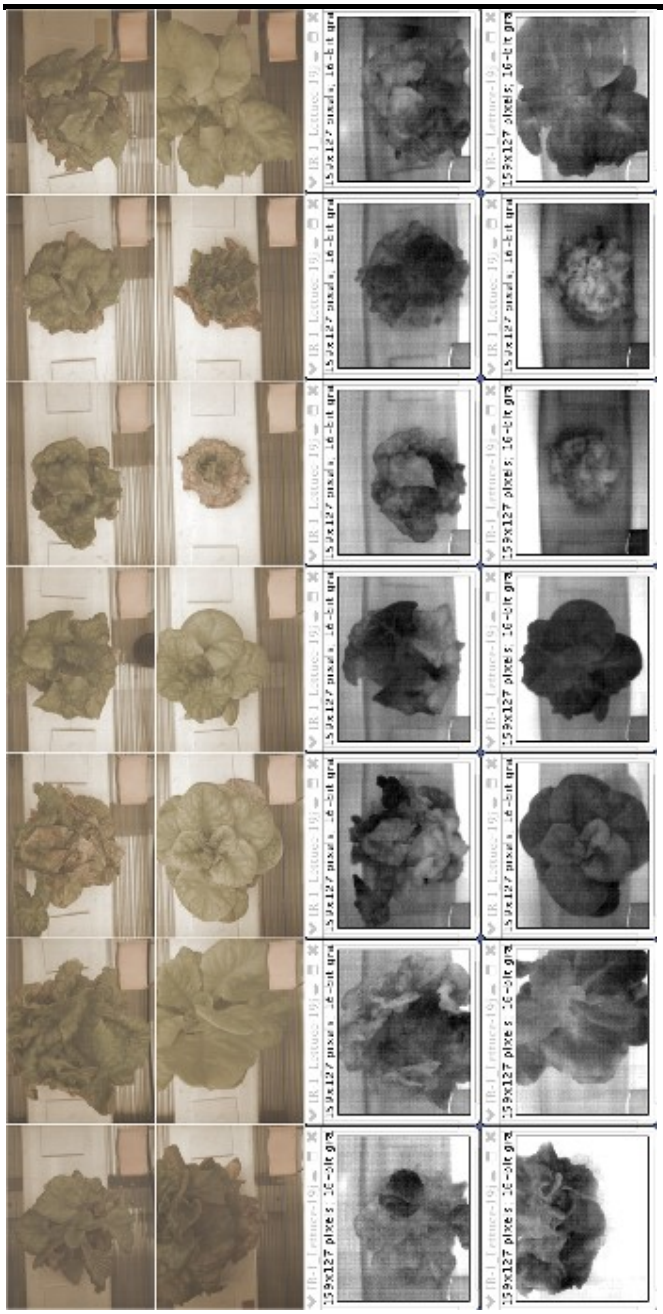

Figure 8: Thermal and visual overview of gullies on rack 6, each with 7 lettuce plants, at harvest time.

Figure 9: Images of harvested control (left) and ACC-treated (right) lettuce heads