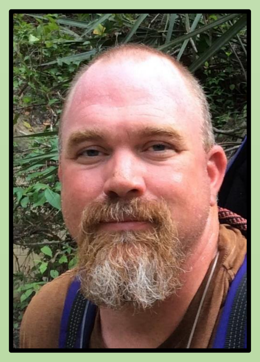
LOW-COST SENSOR-BASED IRRIGATION SYSTEM POWERED BY SOLAR ENERGY

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INTRODUCTION

Soil volumetric water content (VWC) has been successfully used to automate irrigation systems for both agricultural and domestic applications. Measurements are taken using capacitance sensors, and the voltage readings are converted to VWC using soil- or substrate-specific calibration equations.

Expensive dataloggers are used to collect the data and supply plants with on-demand irrigation. When the VWC drop below pre-set thresholds, the irrigation is turned on by using solenoid valves.

Recently new, low-cost and open-source microcontrollers can be used to assemble those systems. However, the use of solar energy to power these systems are yet to be tested.

OBJECTIVES

Our objective was to design and build an automated system to monitoring VWC powered by solar energy and to test the system in the laboratory and at two independent experimental locations cultivated with kale (*Brassica oleracea* var. sabellica) and sweet pepper (*Capsicum annuum*) 'Cubanelle'.

MATERIALS AND METHODS

Location: Both crops were cultivated in a mildly alkaline Fredensborg clay (fine carbonatic, isohyperthermic, Typic Rendolls, Mollisol) soil

Mulching treatments: sunn hemp [Crotalaria juncea] cover crop residue sheet mulch, clear biodegradable plastic mulch, guinea grass [Megathyrsus maximus] hay mulch and no mulch for weed management (Fig. 1).

Monitoring system: We used a low-cost and open-source microcontroller (Mega 2560 R3; Arduino, Ivrea, Italy) with a logging shield (model 2.0; Adafruit, New York, NY) connected to twelve capacitance soil moisture sensors (10HS; Decagon Devices, Pullman, WA) (Fig. 2).

The system was powered by a 15-W solar panel connected to a 12/24VDC charge controller and two 12VDC 7.2 Ah batteries (Fig. 3).

Fig. 1

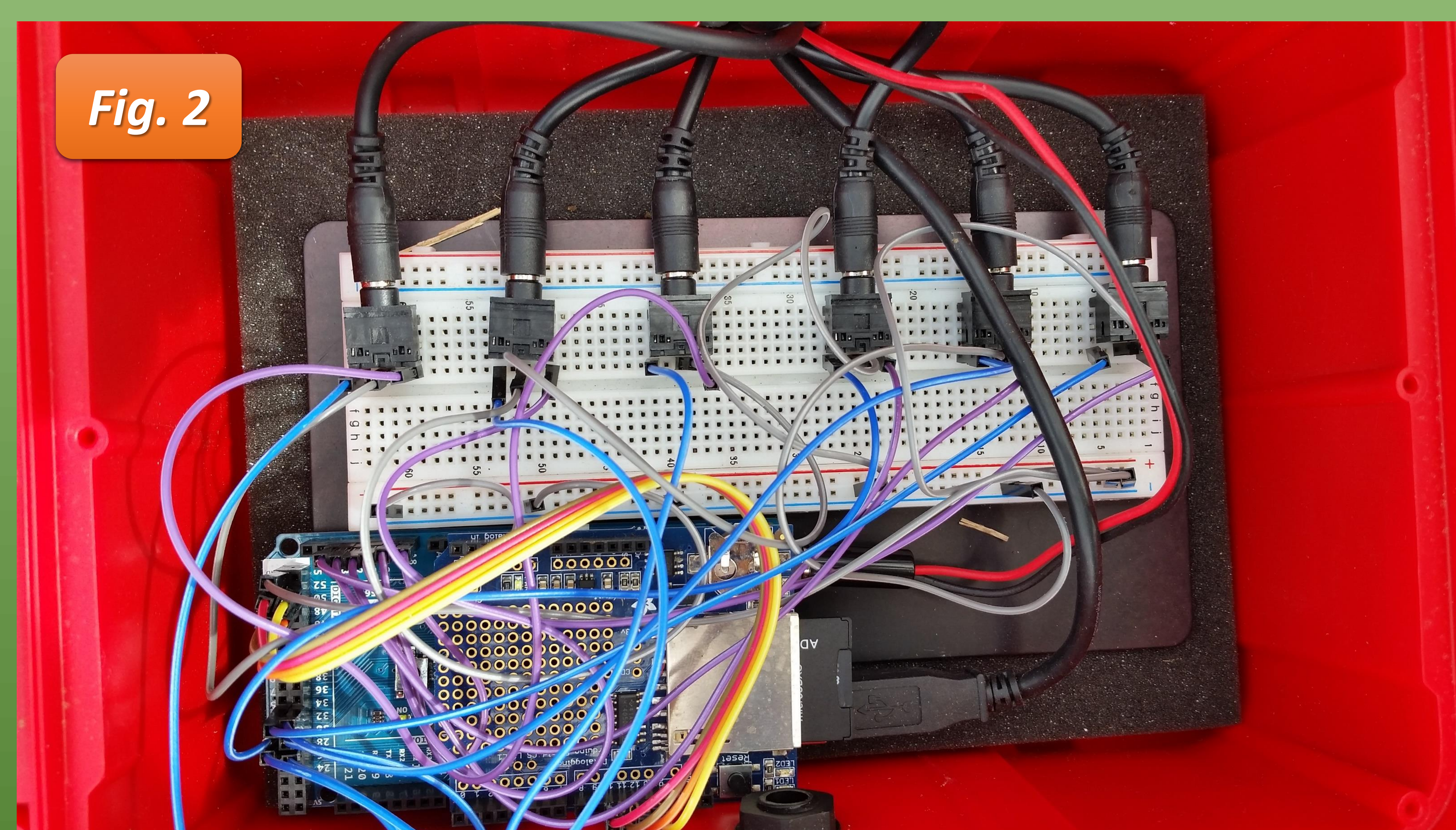

Fig. 2

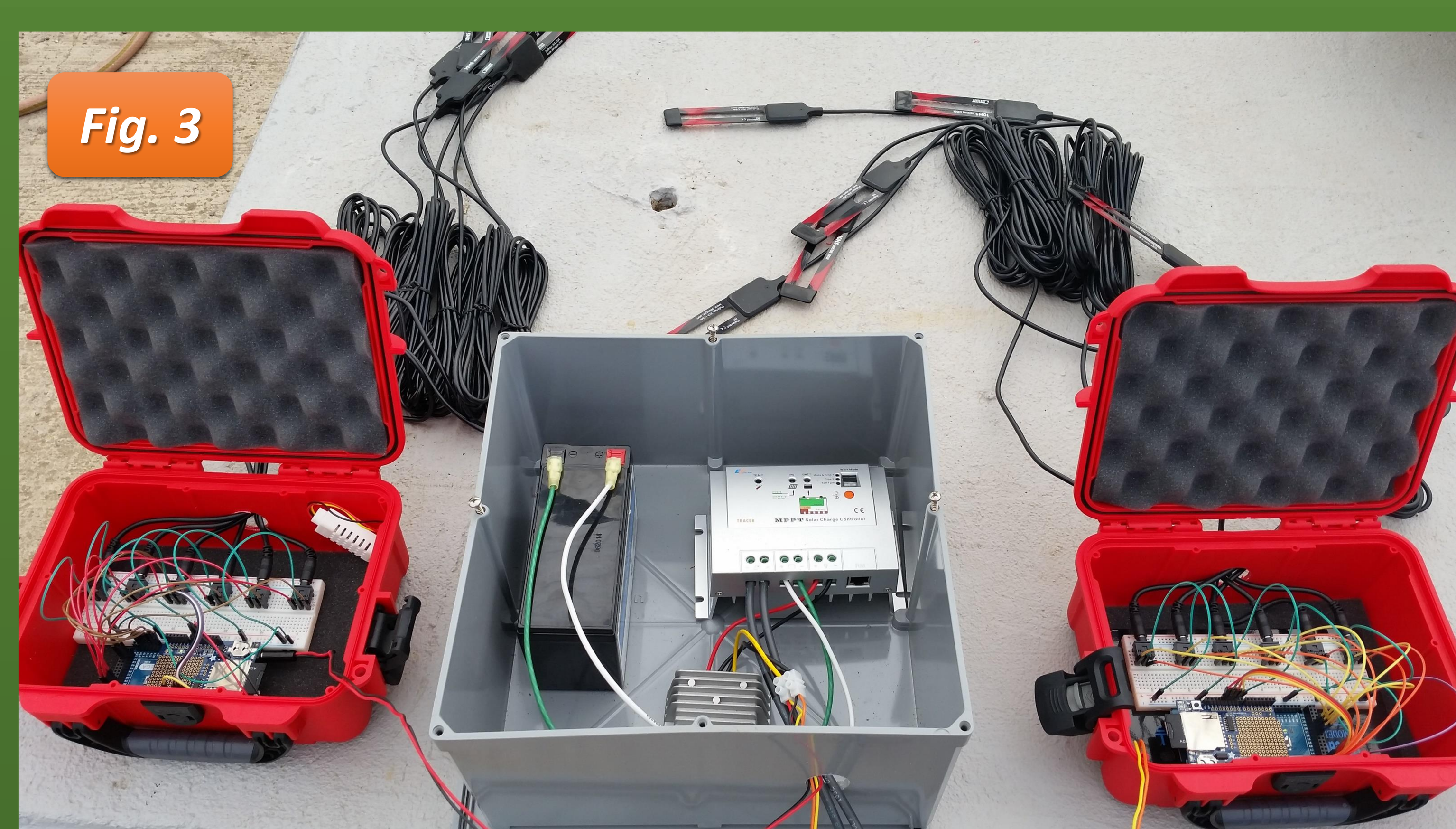

Fig. 3

RESULTS AND DISCUSSION

Results were consistent over time for kale (Fig. 4) but not for sweet pepper (Fig. 5). Improper sensor placement was probably the cause of irrealistic VWC values.

There was a 2-week failure on the trial with sweet pepper (Fig. 5). The irrigation controller required little maintenance over the course of both trials.

The technology is accessible and relatively inexpensive (microcontroller and accessories cost $150 and each sensor cost $115).

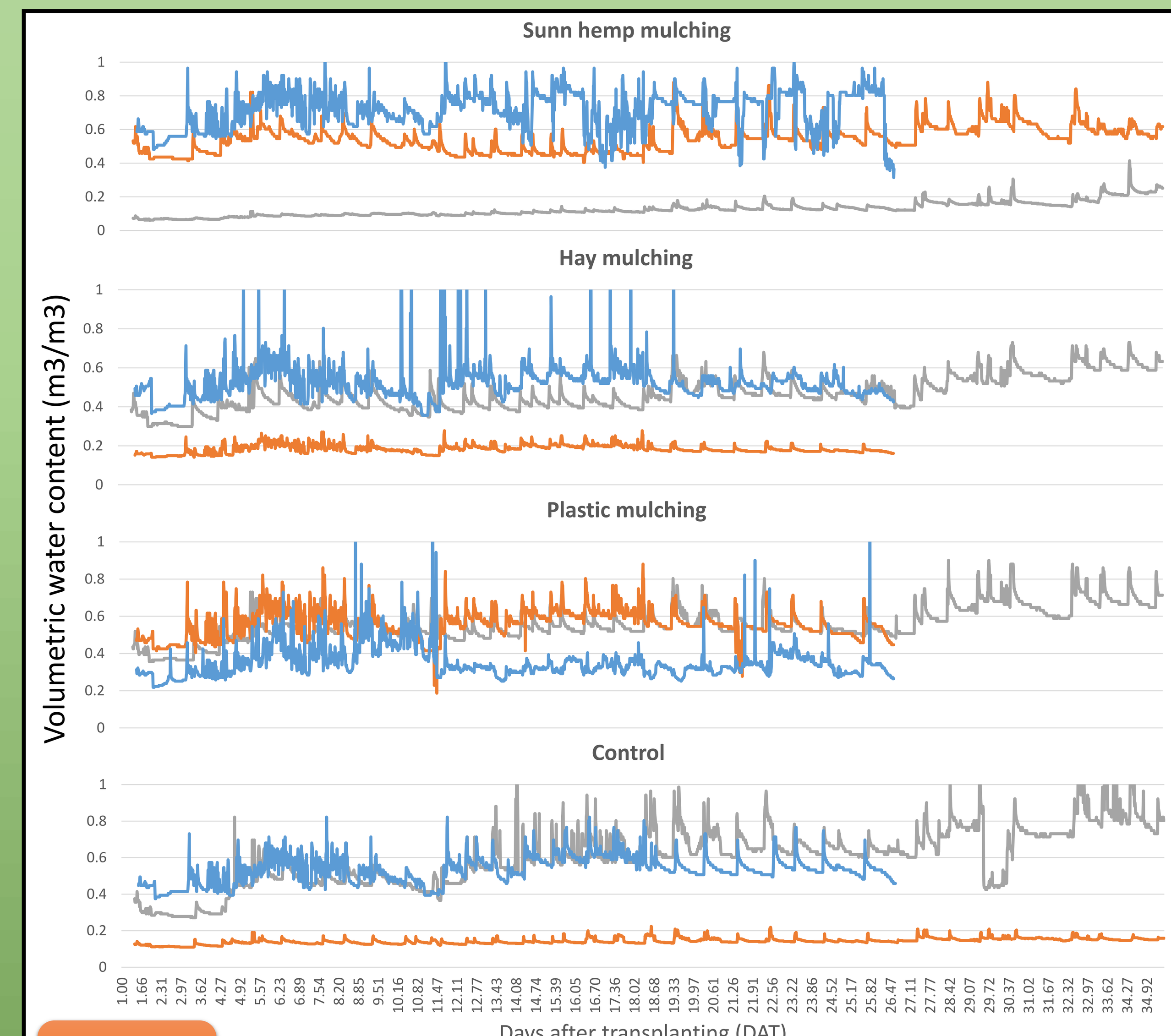

Fig. 4 Validation trial with kale.

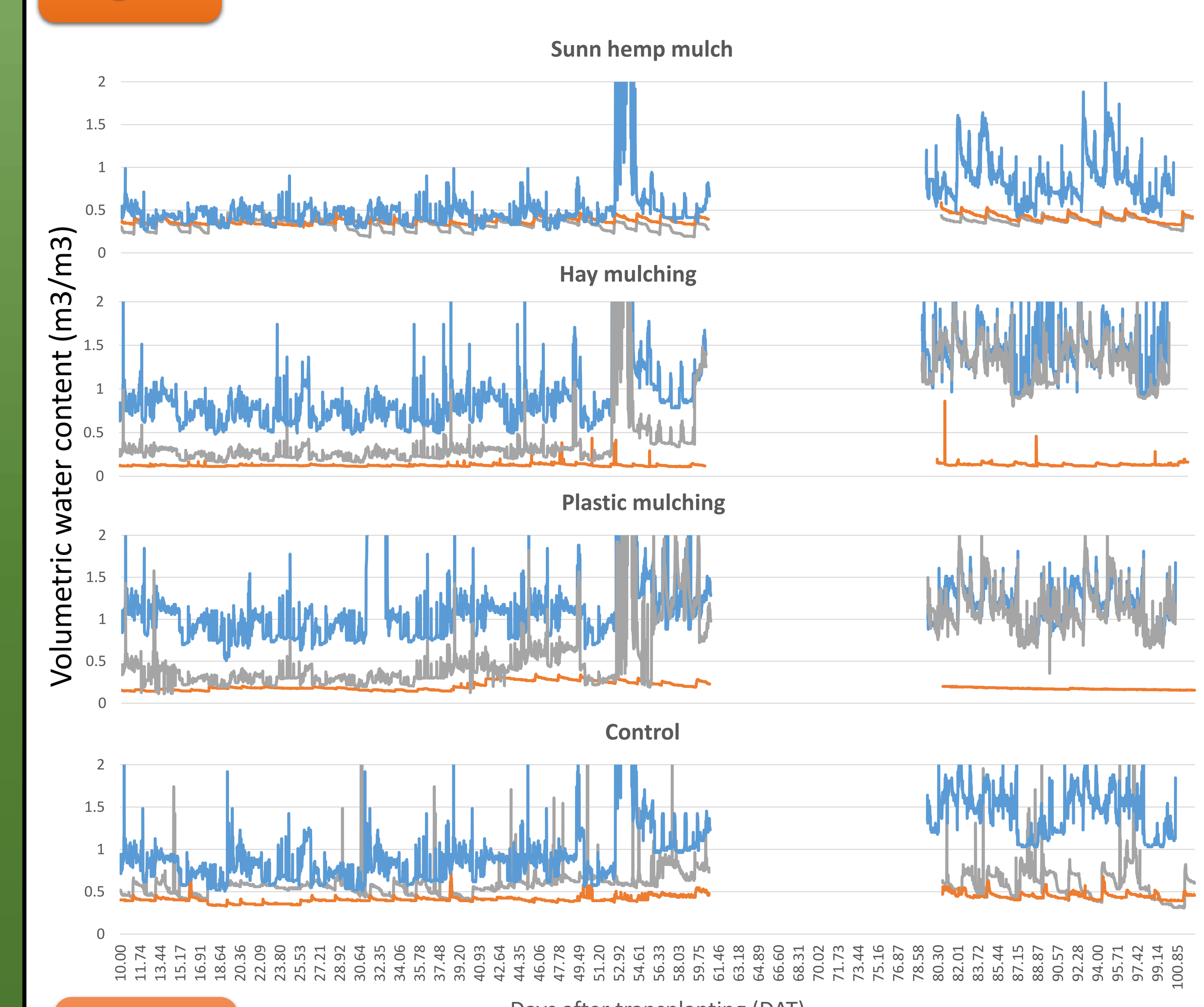

Fig. 5 Validation trial with sweet pepper.

The microcontroller can be used with 6 to 18-V latching direct current (DC) solenoid valves to control irrigation based on real-time readings.

CONCLUSIONS

The low cost of this irrigation controller makes it useful in many applications, including both research and commercial production.

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