4 SoyFACE: the Effects and Interactions of Elevated [CO₂] and [O₃] on Soybean


4.1 Introduction

SoyFACE is the first FACE experiment to focus on a seed legume and on corn and the first to explore the interactions of both elevated (e)[CO₂] and e[O₃] on the growth and development of an arable crop. The intent of the SoyFACE experiment is to orchestrate a coordinated and comprehensive investigation of the impact of atmospheric change on this expansive agroecosystem, addressing questions ranging from rhizosphere biology through to seed composition and employing techniques from genomics to micrometeorology. SoyFACE completed its fourth season of operation in 2004. This chapter provides a description of the SoyFACE facility and its operation and overviews the published results from the 2001–2003 growing seasons.

4.2 Site Description

The SoyFACE facility is located in Champaign, IL, USA (40°02’ N, 88°14’ W, 228 m above sea level; http://www.soyface.uiuc.edu) situated on 32 ha of farmland within the Experimental Research Station of the University of Illinois. The soil is a deep (up to 1.25 m), organically rich Flanagan/Drummer series typical of northern and central Illinois “prairie soils” (fine-silty, mixed, mesic Typic Endoaquoll). Highly detailed information on the physical and chemical characteristics of Champaign County Illinois soils from the USDA Natural
Resources Conservation Service can be found at: http://soils.usda.gov/sur-
vey/online_surveys/illinois/. The field is tile-drained and has been in contin-
uous cultivation to arable crops for over 100 years. Agronomic practices in use
at the site are typical for this region of Illinois. No nitrogen fertilizer is added
to the soybean crop, whereas the corn (Zea mays) crop receives 202 kg N ha–1
(157 kg ha–1 as 28% 1:1 urea:ammonium nitrate liquid pre-plant and
45 kg ha–1 credit from previous soybean N₂ fixation). Soybean (Glycine max L.
Merr. cv Pana in 2001; cv Pioneer 93B15 in 2002 and thereafter) and corn (Pio-
neer cv 34B43) each occupy one-half of the field and follow an annual rota-
tion. In 2001, it was found that cv. Pana grew about 1.5 m at this site and was
vulnerable to lodging, leading to its replacement by the shorter but related cv
93B15 for subsequent years. Both soybean cultivars were similar indetermi-
nate lines of maturity group III which formed 20 000–30 000 nodules m⁻²,
amounting to 25 g m⁻² in mass in the control and 32 g m⁻² in the e[CO₂] treat-
ment plots. Soybean was seeded using a mechanical seed planter to a field
density of about 200,000 plants ha⁻¹at row spacing of 0.38 m (15 in); and the
corn row spacing was 0.76 m (30 in at a seed density of 74 100 ha⁻¹). The exper-
imental plots were oversown by hand on the day of planting and thinned after
emergence to ensure uniform plant density.

An on-site weather station (MetData 1-type; Cambell Scientific, Logan,
Utah) measured air temperature (T_air; for an explanation of abbreviations, see
end of chapter) and relative humidity at a height of 3 m. A quantum sensor
(model QSO; Apogee Instruments, Logan, Utah) measured incident photo-
synthetic photon irradiance (PPI) at a height of 3 m. Data were averaged and
logged at 10 min intervals throughout the growing season. Tipping bucket
rain gauges (model 52202; R.M. Young, Traverse City, Mich.) were distributed
throughout the field and recorded rainfall events in 0.0001 m increments
throughout the season. Weather data is posted on the SoyFACE website
(http://www.soyface.uiuc.edu/weather.htm). The Illinois State Water Survey
weather station (http://www.sws.uiuc.edu/data/climatedb/) in Urbana, Ill.
(40°05' N, 88°14’ W) is situated 3 km north of the SoyFACE site and at the same
altitude.

4.3 Experimental Treatments

4.3.1 Field Layout and Blocking

To control for topographic (<1 m) and soil variation, each 16-ha half of the
field was divided into 16 blocks, each able to accommodate two 20-m diame-
ter octagonal plots. One plot in each block was untreated but otherwise outfitted
with treatment equipment. The atmosphere in the second plot was