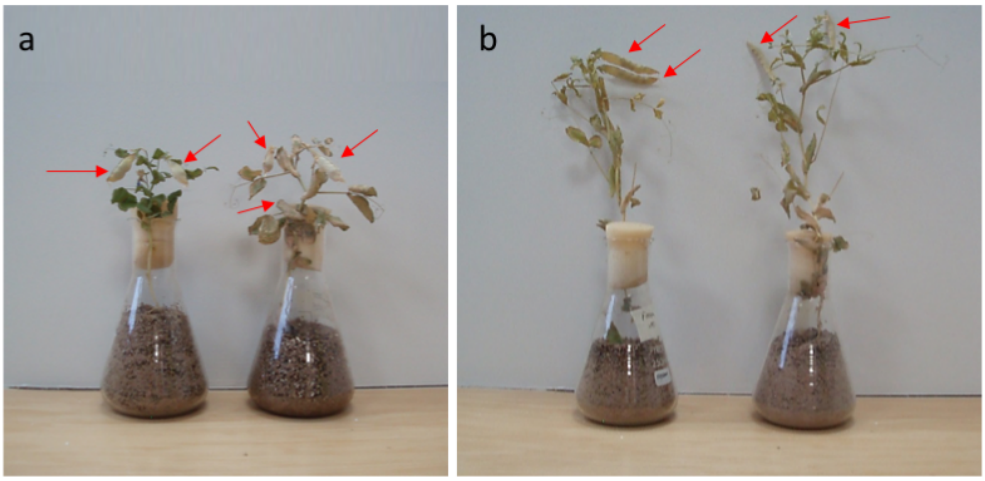
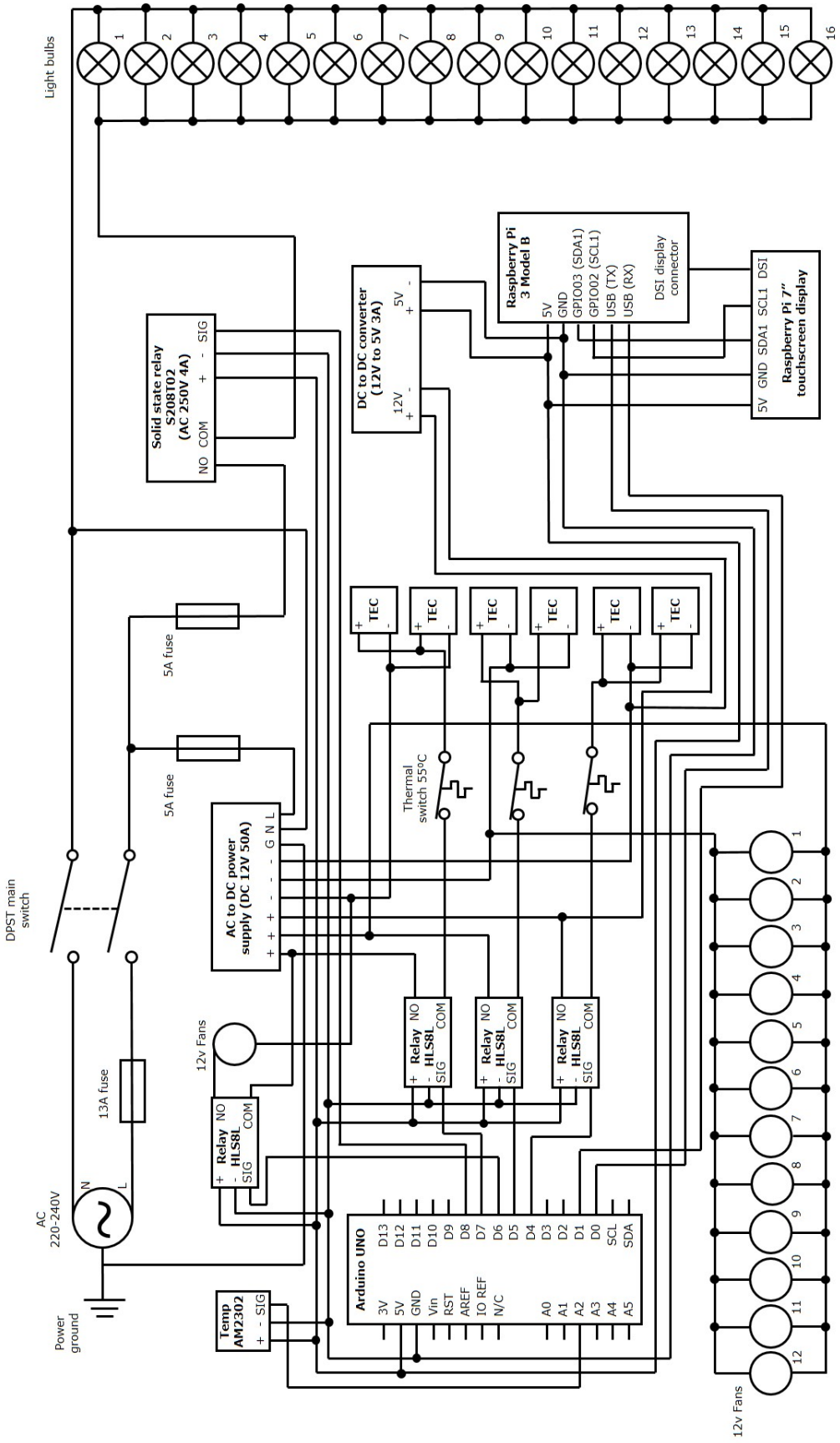
Supplementary Figures

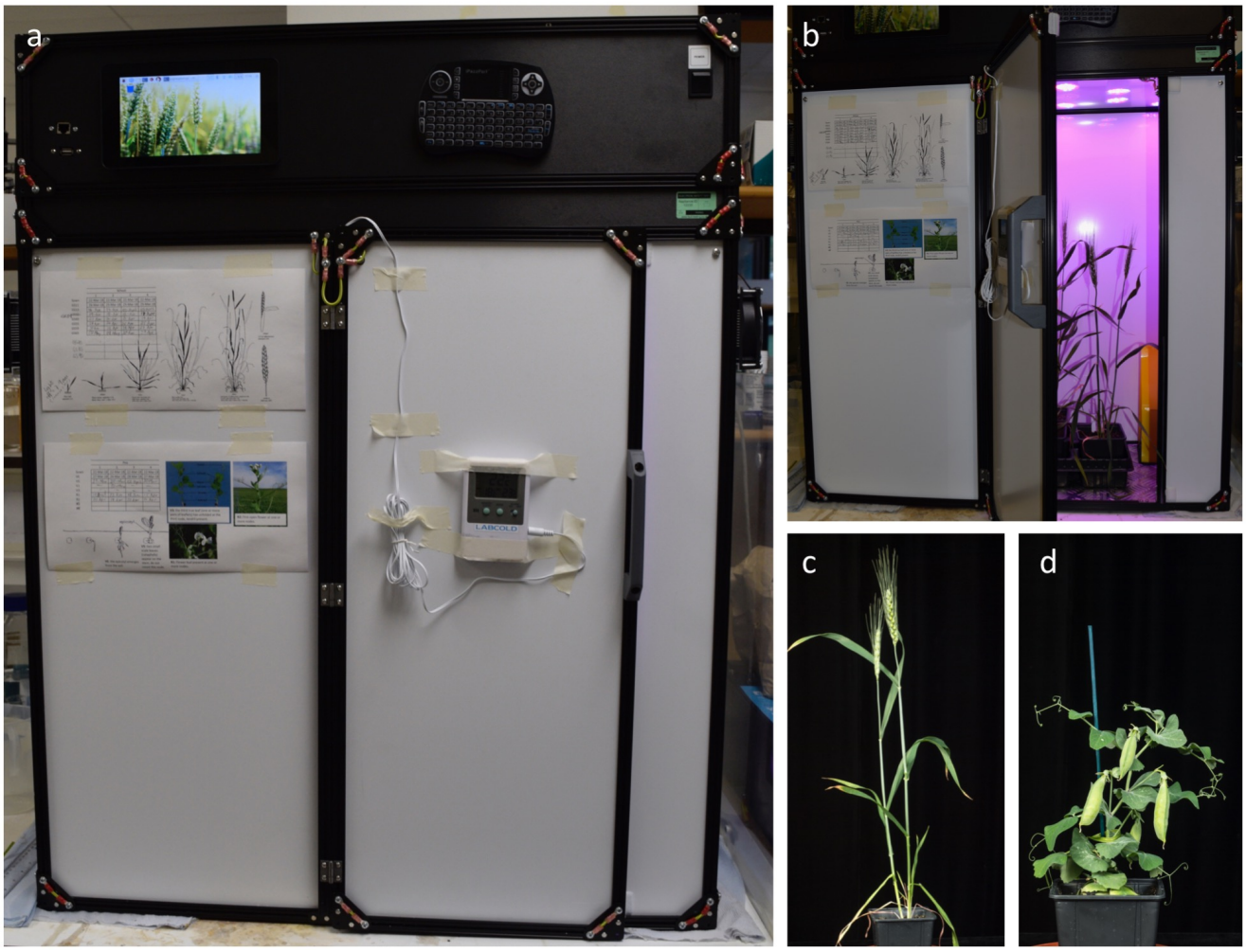


Supplementary Fig. 1 | Mature eight-week-old pea plants, *Pisum sativum* accession JI 2822 (a) and cv. Frisson (b), grown in limited media and nutrition ("flask method") in order to achieve rapid generation advancement. Dry seeds were sterilised in 10% sodium hypochlorite, rinsed in sterile water, chipped and left to germinate in the dark for 3 days on sterile, wet filter paper. Germinating seeds were transferred to flasks containing 250 mL fine perlite and silver sand (mixed 50:50) and FP nutrient media which had been sterilised (composition described in Supplementary Table 48). Flasks were placed in the dark for a further 5 days. The seedlings were inoculated with *Rhizobium*, and the elongated shoot passed through the neck of the flask and held in place with a bung. The base of the flask was covered with a black plastic bag. Plants were grown in a Controlled Environment Room at constant 22 °C with a 16-hour photoperiod. After 3 weeks, flasks were watered with 50 mL FP media once a week. After 8 weeks post germination, plants had mature dry seed ready to harvest as shown (indicated by red arrows). JI 2822 plants grown in the glasshouse under lights required 12 weeks post sowing before mature dry seed were ready for harvest.

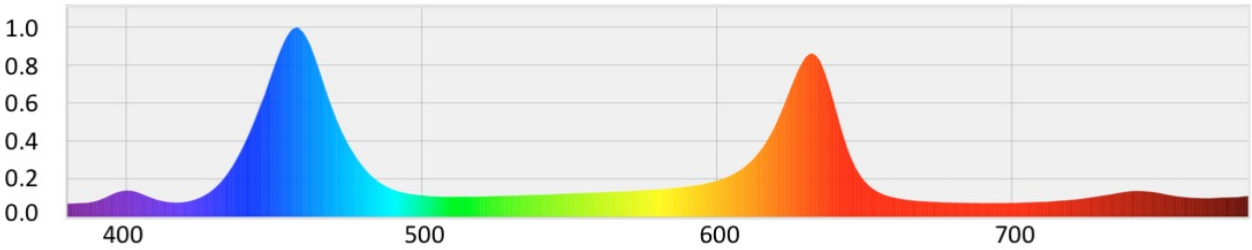
Supplementary Fig. 2| Symptoms of calcium deficiency in wheat grown under speed breeding conditions. Right: Small, circular depressions on the leaf blade; Left: Tip leaf necrosis.



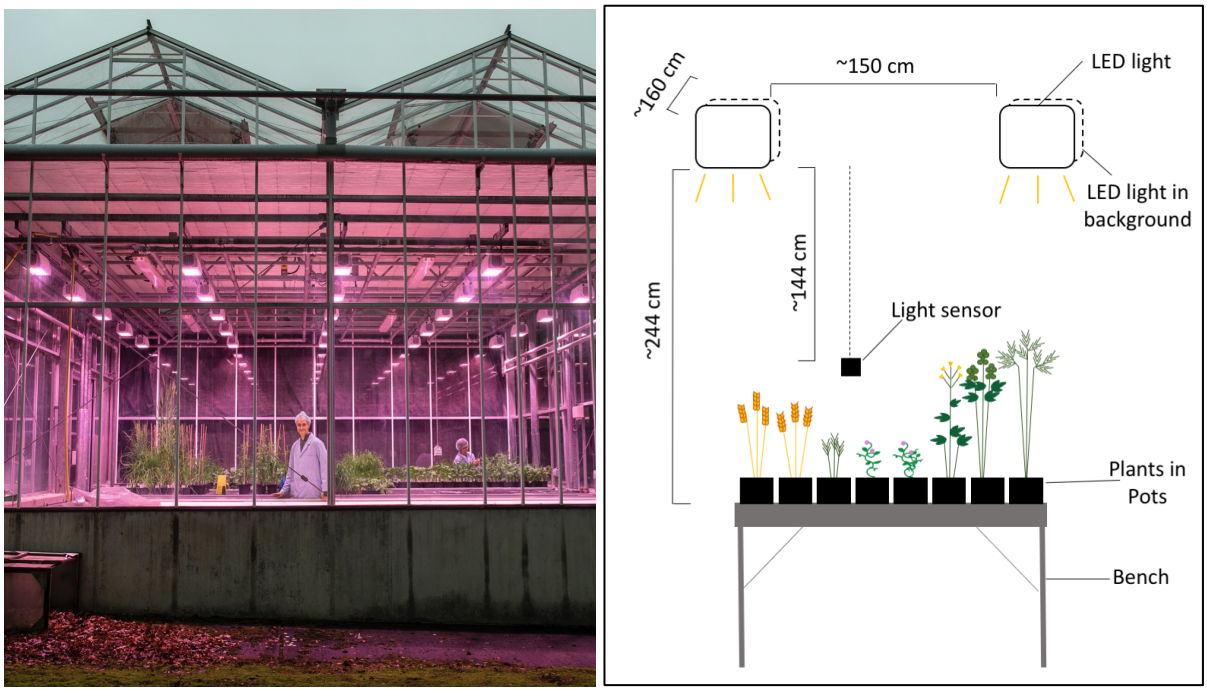
Supplementary Fig 3 | Circuit diagram of the monitoring and control system of the benchtop growth cabinet.



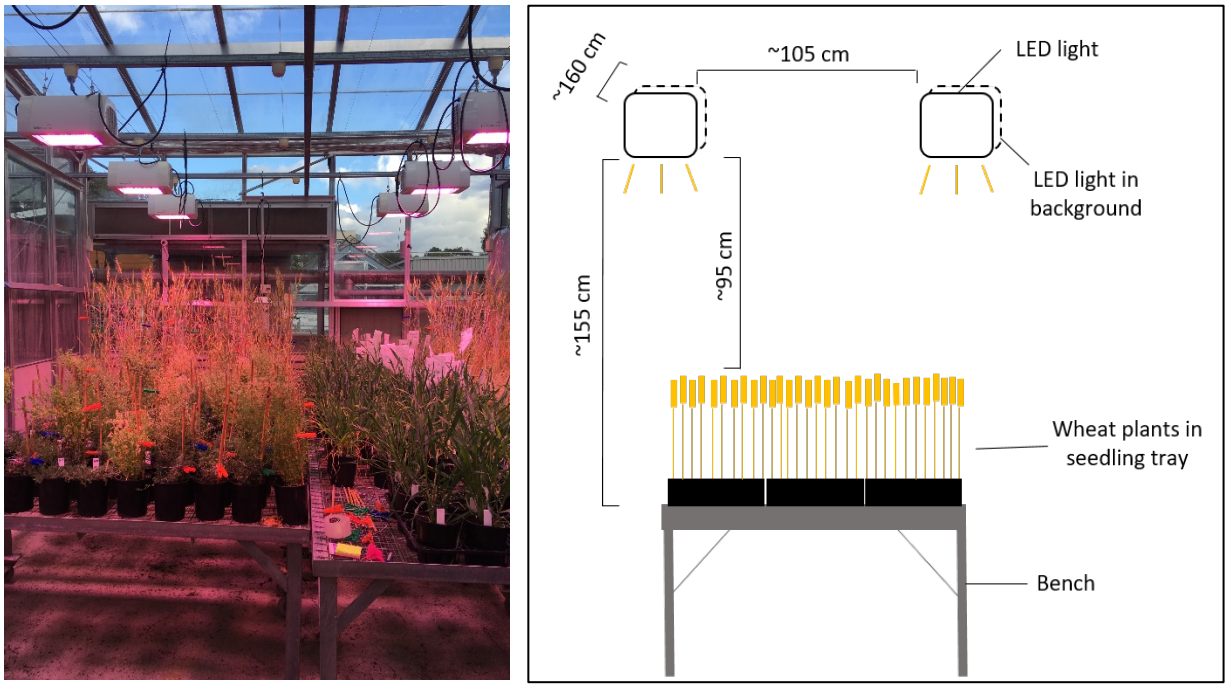
Supplementary Fig. 4 | Benchtop Cabinet for conducting speed breeding. (a) Front view of the cabinet. **(b)** Front view of the cabinet with the door open to show the lighting and wheat plants (*Triticum aestivum* cv. Apogee) growing inside. **(c)** Apogee wheat plant grown in the cabinet, photographed at 55 DAS (Days after sowing). **(d)** Pea (*Pisum sativum*) variety JI 2822 grown in the cabinet, photographed at 50 DAS.



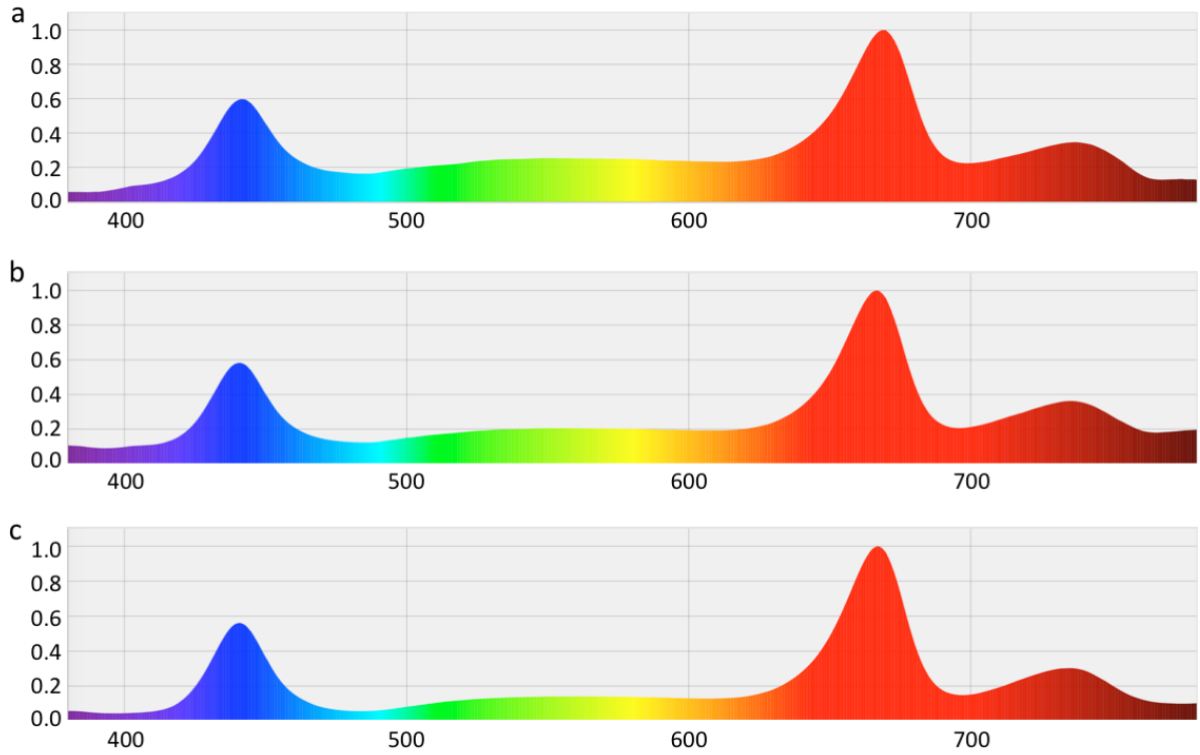
Supplementary Fig. 5 | Light spectrum measurements in in the benchtop growth cabinet 20cm below one of the LED bulbs. The x-axis represents the wavelength of light in nanometres, and y-axis is the normalised spectral power distribution. (Power distribution is measured in $mW \cdot m^{-2}$, and all values on y-axis are divided by the maximum value in the distribution in order to obtain normalised values). Graph was produced from measurements made by the MK350S LED meter from UPRtek, using the uSpectrum software produced by the same manufacturer.



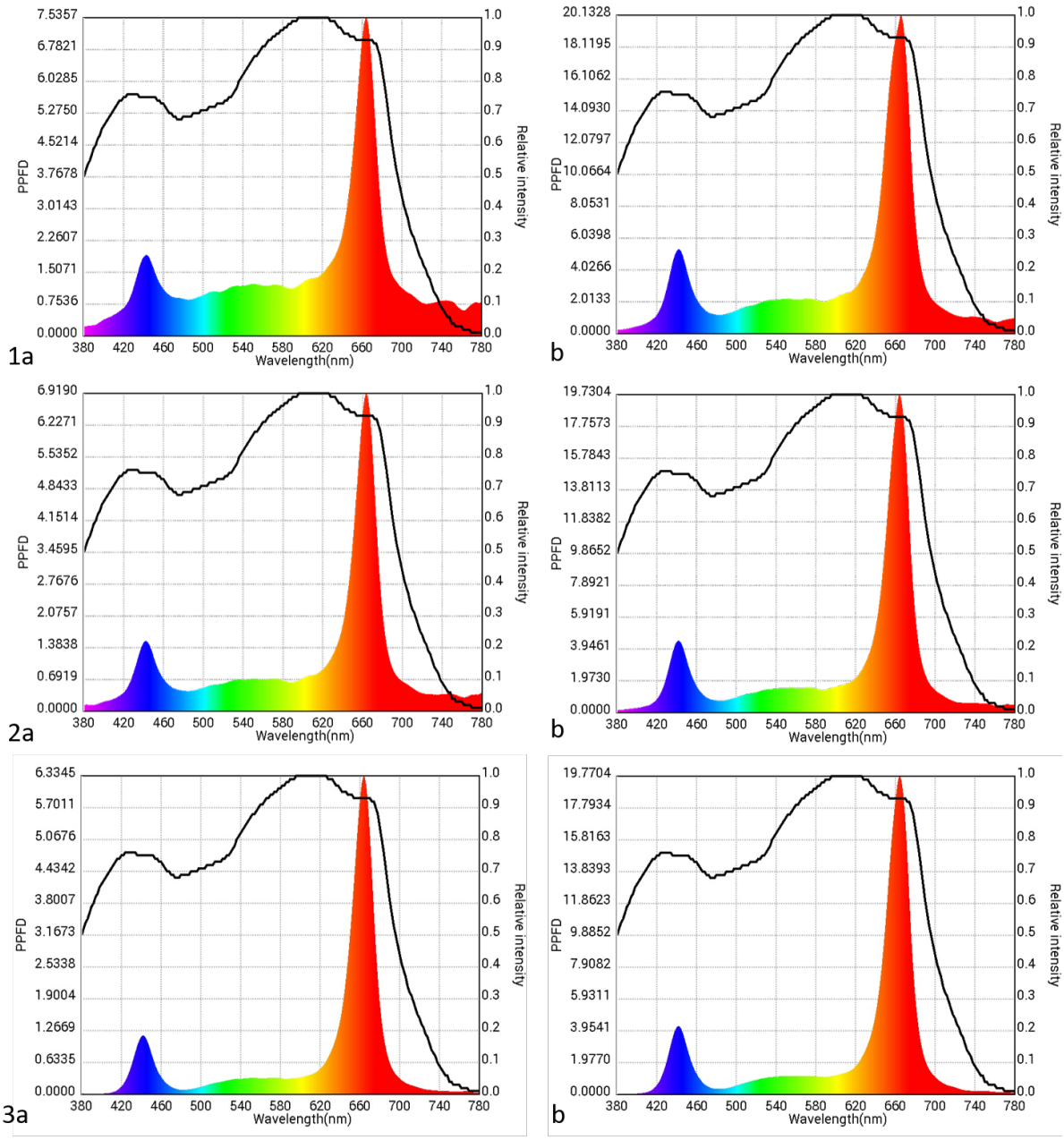
Supplementary Fig. 6 | Glasshouse in John Innes Centre, UK, with Heliospectra LX60C2 light LED supplementary lighting (Left). Schematic of light positioning within the glasshouse relative to the bench, plants and other light fixtures (Right).



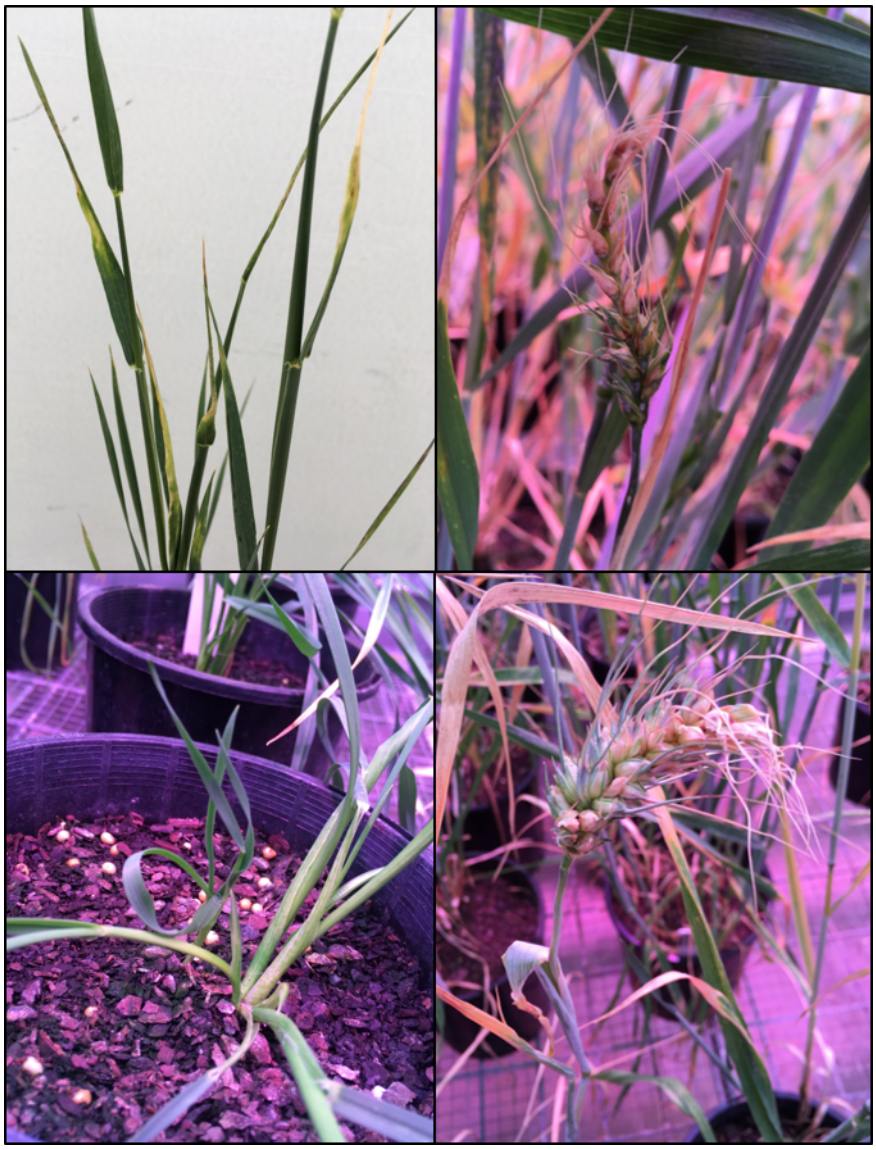
Supplementary Fig. 7 | Glasshouse in St. Lucia, Brisbane, Australia with Heliospectra E602G light LED supplementary lighting (Left). Schematic of light positioning within the glasshouse relative to the bench, plants and other light fixtures (Right).



Supplementary Fig. 8 | Light spectrum measurements in JIC Glasshouses under a Heliospectra LX602C LED fixture (a) Spectrum measurement in the glasshouse at bench level (244 cm from light fixture) on a clear, sunny day at 12 noon. **(b)** Spectrum measurement in the glasshouse at bench level (244 cm from light fixture) on a cloudy day at 12 noon. **(c)** Spectrum measurement in the glasshouse at bench level (244 cm from light fixture) at night. The x-axis of all three graphs represents the wavelength of light in nanometres, and y-axis is the normalised spectral power distribution. (Power distribution is measured in $mW \cdot m^{-2}$, and all values on y-axis are divided by the maximum value in the distribution in order to obtain normalised values). All graphs were produced from measurements made by the MK350S LED meter from UPRtek, using the uSpectrum software produced by the same manufacturer.



Supplementary Fig. 9 | Weighted McCree action spectrum and photosynthetic photon flux density (PPFD; µmol·m^{-2}·s^{-1}) from under a Heliospectra E602G light using the Spectrum Genius Essence Lighting Passport light sensor and associated Spectrum Genius Agricultural Lighting app (AsenseTek Inc., Taiwan). (1) Centre measurement at 12 noon on a clear, sunny day, **(2)** Centre measurement at 12 noon on an overcast day and, **(3)** Centre measurement at night; **a**, bench level (155 cm from light) and **b**, approximate wheat spike height (95 cm from light). Figures were exported from the software.

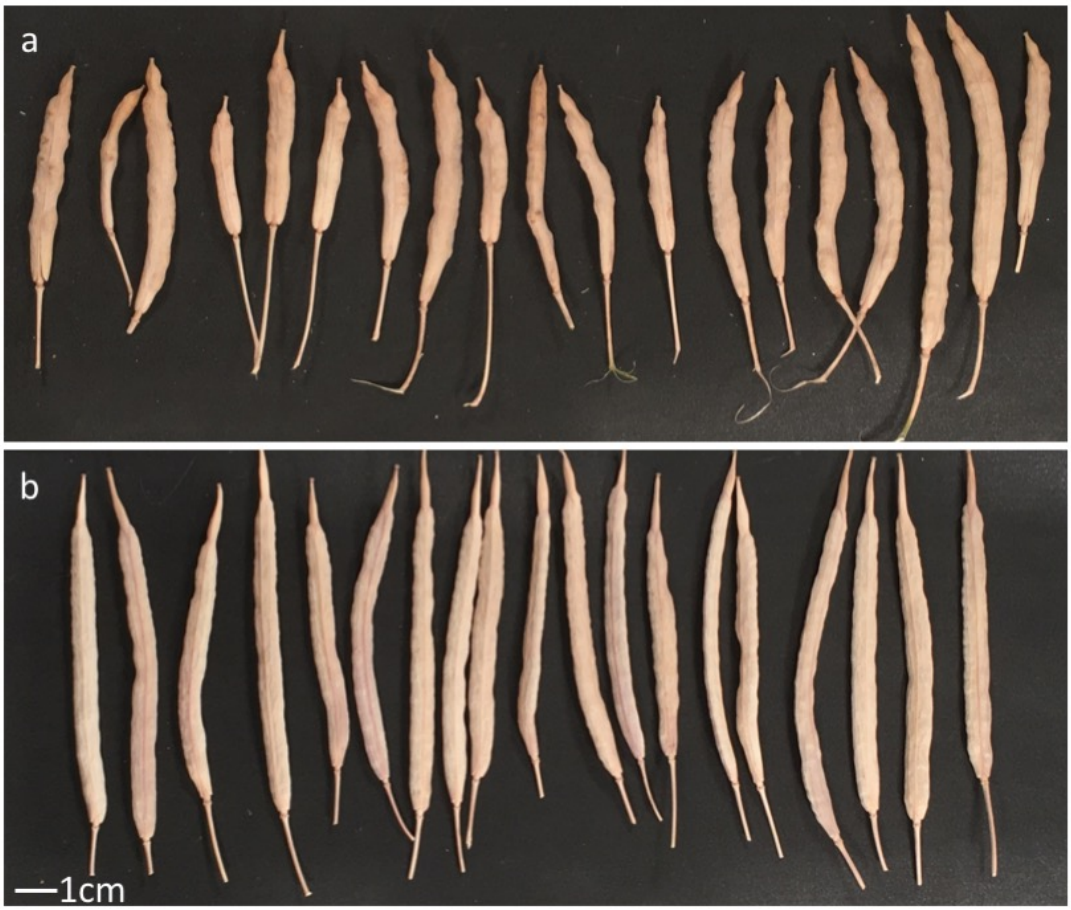


Supplementary Fig. 10 | Symptoms of copper deficiency in wheat grown under speed breeding conditions. Left (top): Curling and death of young leaf tips and down the leaf blade; Left (bottom): Young leaves becoming stuck as they emerge and forming loops or curling; Right (top and bottom): Spikes wither and turn white at the tips. No seed is produced in these areas and spikes may be twisted.

Supplementary Fig. 11 | Symptoms of iron deficiency in wheat grown under speed breeding conditions. Young leaves appear striped with yellowing of the interveinal spaces.

Supplementary Fig 12 | Barley spikes from plants grown under Heliospectra LED lights. Barley cv. Golden Promise from 22-hour light regime (left) and 16-hour light regime (right). Scale bar is 5 cm.

Supplementary Fig. 13 | Pods from *Brassica rapa* R-0-13 grown in LED-supplemented glasshouses at the John Innes Centre, UK under (a) a 22-hour photoperiod and (b) a 16-hour photoperiod.



Supplementary Fig. 14 | Pods harvested from *Brassica napus* RV31 grown in LED-supplemented glasshouses at the John Innes Centre, UK under (a) a 22-hour photoperiod and (b) a 16-hour photoperiod.