**Supplementary Information**

**Grain size modulates volcanic ash retention on crop foliage and potential yield loss**

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**Material and methods**

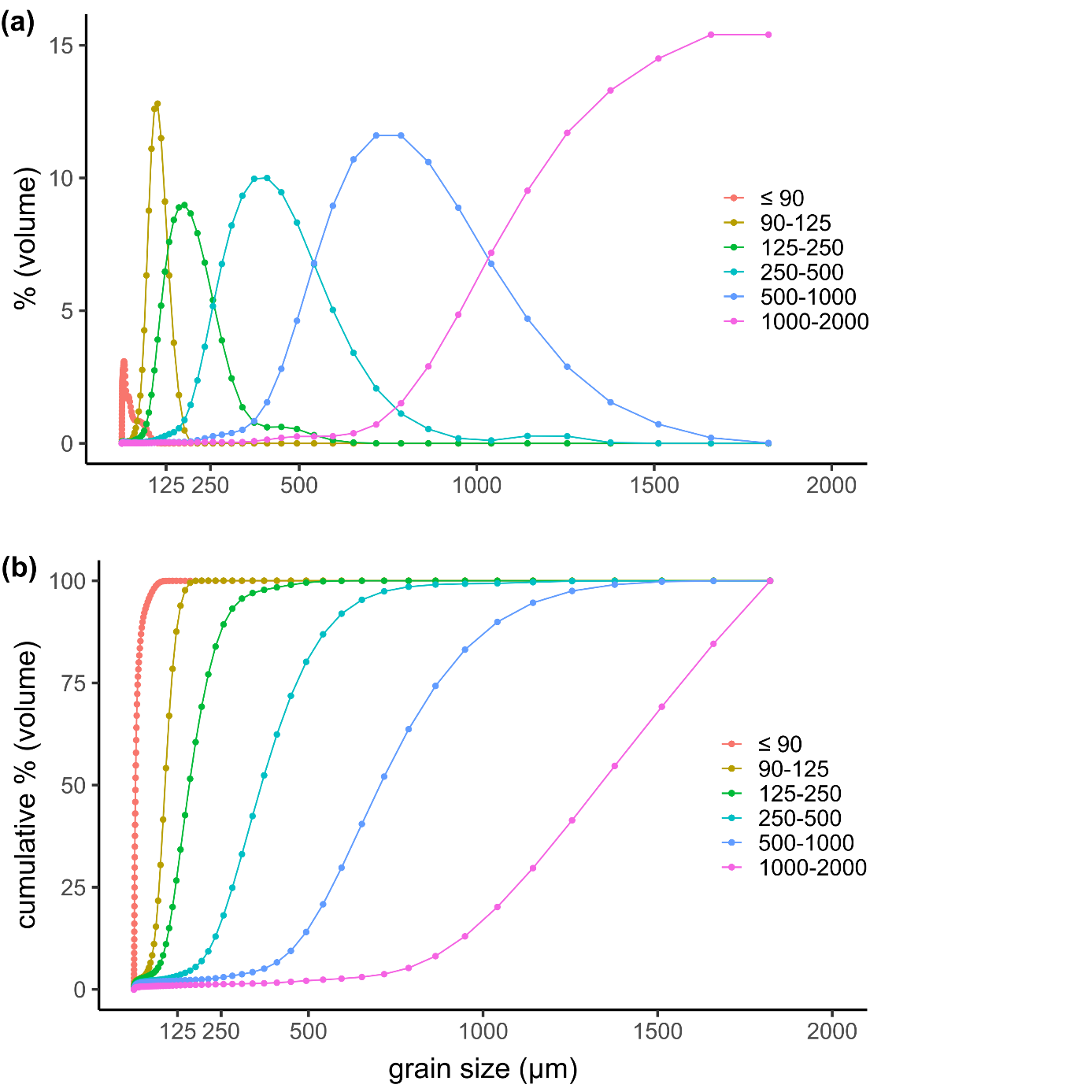


Figure S1: Grain size characteristics of the six ash size ranges (≤ 90, 90-125, 125-250, 250-500, 500-1000, 1000-2000 µm) used for simulating ash fall on tomato and chilli pepper plants: distributions (a) and cumulative distributions (b).

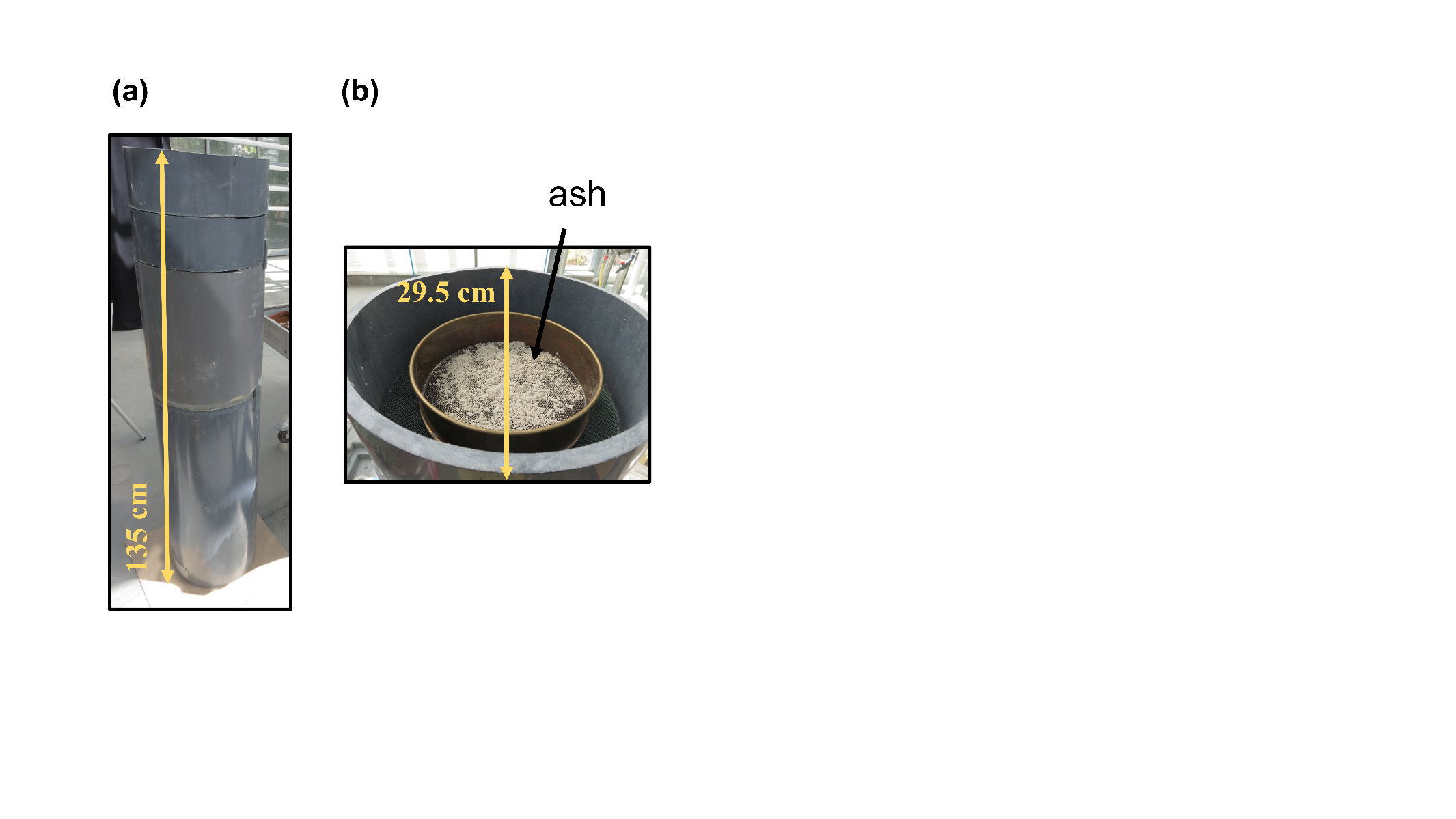


Figure S2: Photos of the ash fall simulator used to apply ash on tomato and chilli pepper plants. The device consists of *PVC* tube with three 1-mm opening meshes placed at 75, 110 and 120 cm from the tube base: side view (a) and top view with ash introduced through a 2- cm mesh sieve (b).

**Results**

Table S1: Summary statistics (mean, standard deviation (*sd*), minimum (*min*) and maximum (*max*) value, first (*q1*)and third (*q3*) quartile) of the percentage of foliar cover of tomato and chilli pepper plants coated with ash. The results are shown for the six ash grain size ranges tested in dry and wet conditions at leaf surfaces.



Table S2: Treatments significantly different according to the Tukey (*HSD*) test with the difference between group means and the associate adjusted *p*-value (*p.adj*). The test was performed to evaluate the effect of (i) humidity conditions at leaf surfaces for tomato and chilli pepper plants and (ii) crop type in dry leaf conditions on the percentage of foliar cover coated with ash. “125”, “250” and “500” stand for the 90-125, 125-250 and 250-500 µm ash size ranges, respectively.





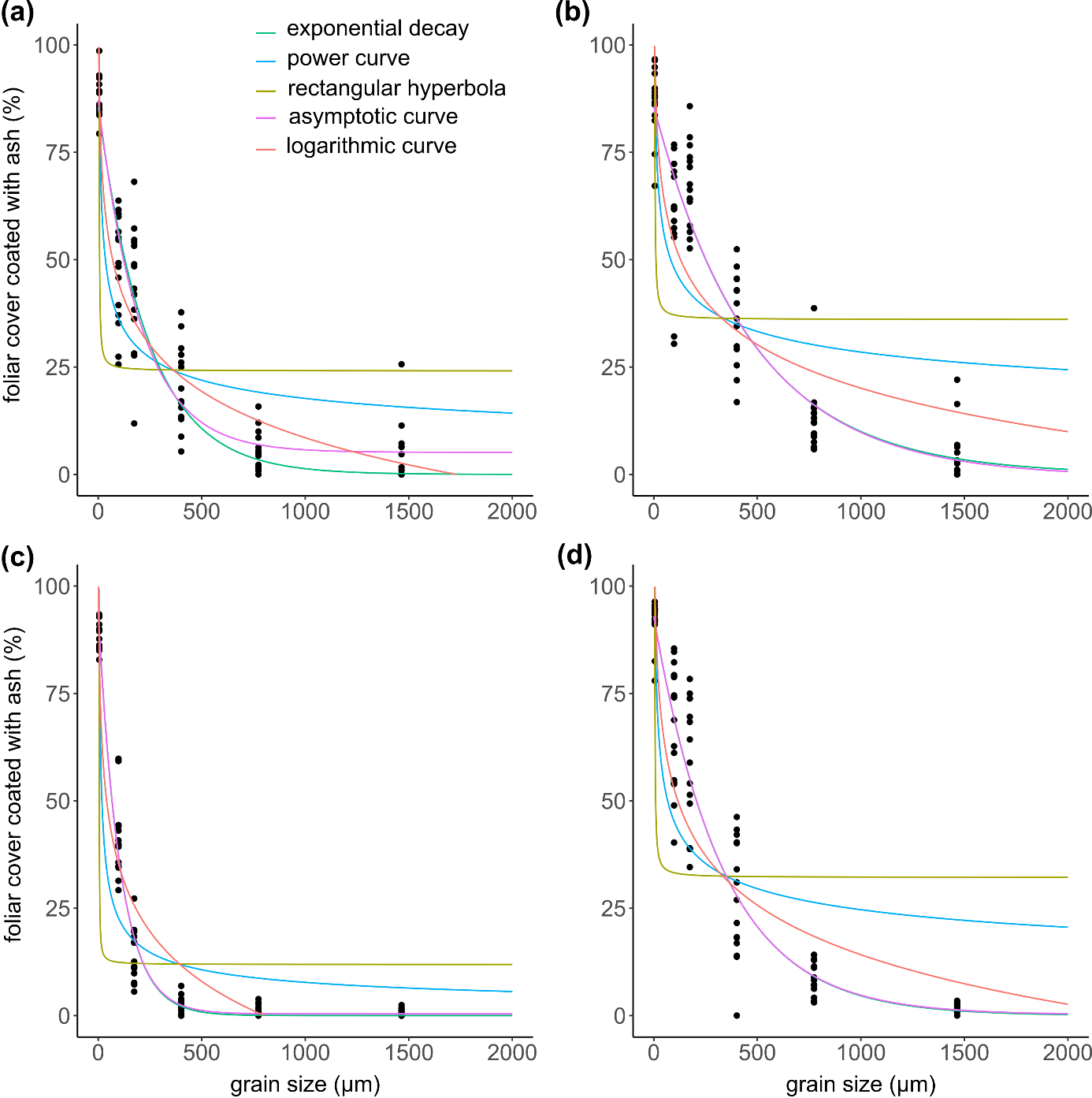


Figure S3: Fitting of the experimental datasets to represent the relationship between the percentage of foliar cover coated with ash and ash median grain size for tomato in dry (a) and wet (b) leaf conditions and chilli pepper in dry (c) and wet (d) leaf conditions. Five convex models were tested: exponential decay, power curve, rectangular hyperbola, asymptotic curve and logarithmic curve.

Table S3: Lack-of-fit analysis (F\* statistics and corresponding *p*-values) of the five convex models (exponential decay, power curve, rectangular hyperbola, asymptotic curve and logarithmic curve) used to fit the four experimental datasets obtained by exposing tomato and chilli pepper in dry and wet leaf conditions to ash varying in grain size (see Fig. S3).



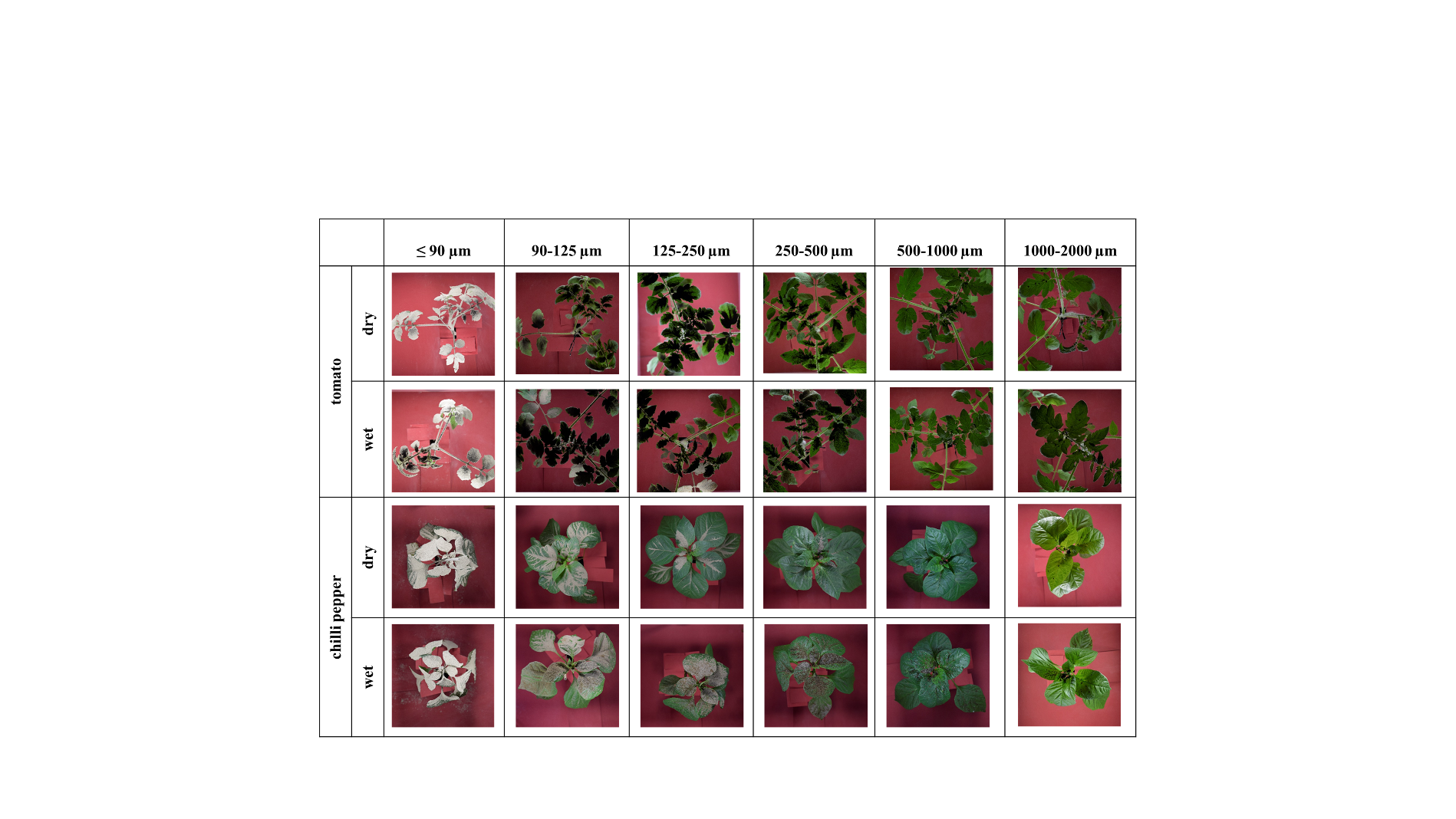


Figure S4: Photos of the tomato and chilli pepper plants after exposure to ash in dry and wet conditions at leaf surfaces. The columns correspond to the six ash size ranges tested (≤ 90, 90-125, 125-250, 250-500, 500-1000, 1000-2000 µm).

**Discussion**

Table S4: Terminal fall velocity of individual particles of 10, 100, 170, 410, 710 and 1470 µm as calculated using the drag model of Bagheri and Bonadonna (2016). The particles are non-spherical (flatness = 0.7, elongation = 0.7) and have a density of 2.54 g m-3.



Table S5: Parameter values used in the simulation of potential yield loss for tomato and chilli pepper plants exposed to ash. *k:* light interception coefficient; *Q:* incident radiation; *RUE:* radiation use efficiency; *CBP*: canopy partitioning factor; *ILAI*: proportion of *LAI* covered by ash and which does no operate photosynthesis; *DCB*: proportion of the biomass covered by ash which undergoes senescence; *TNL*: time needed for the plant to produce new leaves.



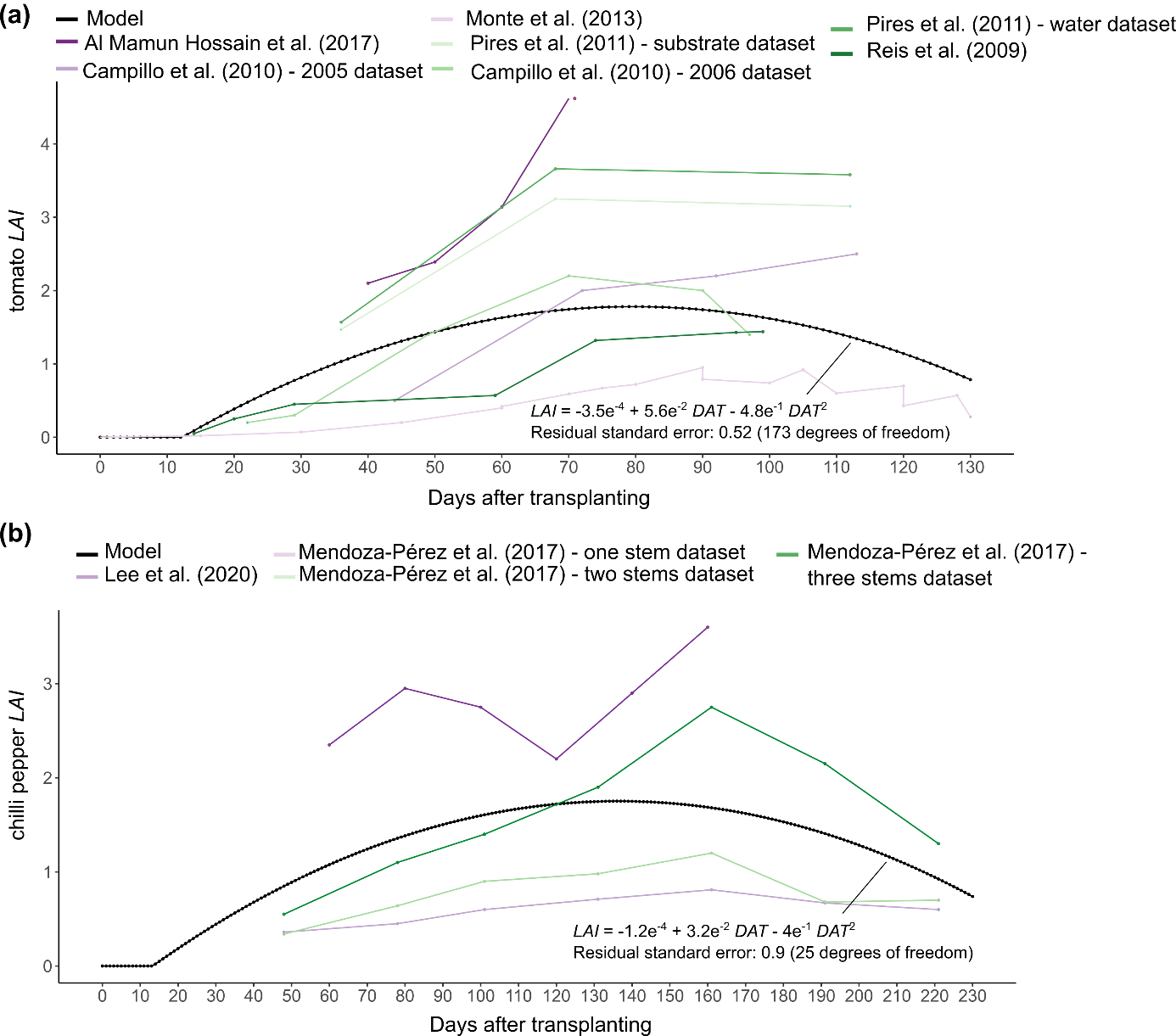


Figure S5: Temporal evolution of the leaf area index (*LAI*) for tomato (a) and chilli pepper (b) plants as modelled by fitting various datasets reported in the scientific literature. The *aomisc* package in *R* (Onofri, 2020) was used to obtain the best fit. Transplanting of tomato and chili pepper was assumed to take place 30 days after sowing. DAT refers to day after transplanting.

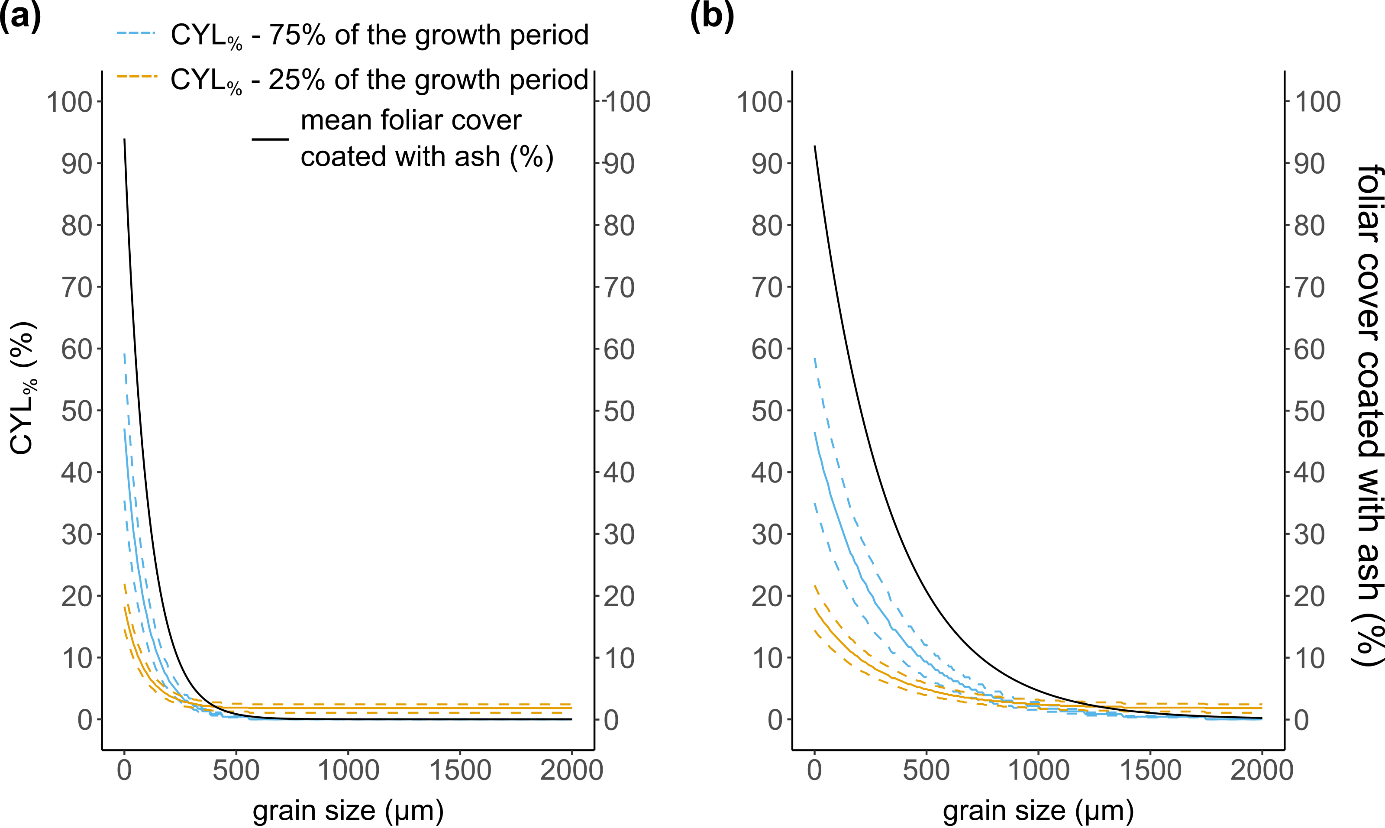


Figure S6: Potential crop yield loss (*CYL%*, first quartile, median and third quartile) estimated for chilli pepper plant as a function of ash grain size in dry (a) and wet (b) conditions at leaf surfaces.

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