Fact-Checked Science

PAPER CHECK · MAGNETIC FIELDS AND PLANTS

Mint in a near-zero coil made less oil in one lab's test, which didn't measure growth

Three University of Turin researchers kept cuttings of wild mint for four weeks in a coil that cancelled the local field to about 30 nT, and report less essential oil, altered fluorescence and more hydrogen peroxide in the roots [1 p. 1]. We read the paper and its supplement, which the site's owner supplied. Many readings differ, but the paper didn't measure growth and reports no sham coil, and Earth's field at its real lows is far stronger than the coil's.

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OUR ANALYSIS marks our own reasoning and calculations, every number from our re-runs and our readings of the paper's figures among them, and the verdicts are our assessment. Everything else comes from the numbered sources. For the paper [1], p. gives a page of the journal's PDF, Fig. and Table a figure or table, and Fig. S1, Tables S1–S4 and Data Set S1 the supplement.

A reported difference in a coil, and a design that can't say why

OUR ASSESSMENT

~30 nT
the coil's field at its sensor, about 1,400 times below the laboratory's own 43 µT [1 p. 2]

~7 µT
the typical surface field at the Laschamp excursion's deepest moment in the preferred global model, about 240 times the coil's (our analysis) [6]

0
measures of growth, biomass or survival in the paper, which reports chemistry, genes and fluorescence [1 pp. 2–4]

THE PAPER'S CLAIMS

OVERSTATED

"Geomagnetic field reduction induces abiotic stress"

The paper's title [1 p. 1]

Many readings differ, and the field was changed on purpose. But no growth, survival or damage was measured, maximum PSII efficiency was unchanged [1 Table S2], shoot H_2O_2 fell [1 p. 9], and no sham coil is reported. The conclusions themselves say "associated" and that the study "does not directly demonstrate mechanistic relationships" [1 pp. 11–12]. And the only per-sample data in the supplement, for flavonoids only, can't show independent replicates. See section 4 and section 5.

TRUE

Coil plants gave altered photosynthetic readings in this experiment

The abstract's words are "NNMF altered photosynthetic performance" [1 p. 1]

PSII yield in the light was 0.13–0.22 against 0.19–0.27, at P = 0.001–0.032 [1 Table S3], and 22 of that table's 39 readings survive a false-discovery correction (our analysis). Beside that: the abstract's "photosynthetic energy deficit" isn't measured, as there is no gas exchange or ATP; no sham is reported; and the same lab gets lower PSII yield and quenching after 10 seconds in this coil, though fast dissipation moves the other way [4 pp. 4, 7]. We rate the readings, not that the field caused them. See section 3 and section 6.

UNCONFIRMED

"reduced essential oil yield and lower accumulation of major monoterpenes, particularly carvone"

The paper's abstract [1 p. 1]

Total oil was 19% lower and carvone 21% lower, at P = 0.030 and 0.010, on three samples per group [1 Table 1]. Those P values reproduce, but none of the table's 24 rows survives a correction for multiple tests, and under Welch's test total oil is P = 0.069 (our analysis). Counted post hoc as just the two outcomes the abstract names, both stay below 0.05 under Student's t, though not under Welch's. We found no independent repeat, and in this lab's coil basil's oil rose [16 Abstract]. See section 5 and section 9.

PARTLY TRUE

"elevating oxidative stress in heterotrophic roots"

The paper's discussion [1 p. 10]

Root H_2O_2 rose about 80% and root protein fell about 35% [1 p. 9]. But no damage marker or enzyme activity was measured, root antioxidant transcripts were 9–20% lower, as we read them off the figure [1 Fig. 5C], and the authors say no spike-recovery test was done on the peroxide assay [1 p. 3]. Shoot H_2O_2 fell about 15%, which the abstract leaves out [1 p. 9]. In this lab, Arabidopsis roots fell too, while maize roots rose [13 §3.3][19 §Results]. See section 4 and section 9.

1 · WHAT WE READ

The paper and its supplement, read in full

Three researchers at the University of Turin published the paper in the peer-reviewed journal *Plant Stress* on October 28, 2026 [1 p. 1]. ScienceDirect refused our tools, so the site's owner supplied the PDF and the supplement. S0 News linked the paper on November 3, 2026 [2].

The paper

Read in full. Received August 10, revised October 9, accepted October 26, 2026, under a CC BY 4.0 licence [1 p. 1]. Funded by the University of Turin and by Fondazione CRC's MINTIS project; the authors declare no competing interests, and say "Data will be made available on request" [1 p. 12].

The supplement

Read in full: Fig. S1, Tables S1–S4 and the workbook Data Set S1, which the site's owner downloaded for us. We read the workbook as data, running nothing in it. The table below says what each part settled [1 Tables S1–S4].

What the supplement settled

PART	WHAT IT SHOWS
Fig. S1	Photographs of three flasks on a clear platform at the centre of the octagonal coil frame, with a lamp above it, and of three flasks in a row on a white-covered bench under a similar lamp. The paper calls this "a representative experimental setup" [1 p. 2]. No sham coil is visible around the controls, in this narrow crop. The photographs don't show how far apart the two stood, and the shoots per flask can't be counted.
Table S1	Primers for the nine pathway genes reported, and none for *DXS*, *DXR* or *IDI*, though Fig. 1A draws them. As far as the table shows, those three weren't measured, so nothing was dropped from Fig. 1B.
Table S2	26 OJIP parameters, 2 below P = 0.05. Fv/Fm is 0.82 ± 0.01 in both groups, P = 1.000. No n is printed; the means fit 4 control and 7 coil readings (section 5).
Table S3	39 PAM parameters, 26 below P = 0.05, with the numbers behind Fig. 2G–J. No n is printed; the means fit 4 control and 6 coil readings (section 5).
Table S4	Hormone concentrations, as mean ± SD, with asterisks on 12 of 18 comparisons and a note saying n = 3.
Data Set S1	Flavonoid peak areas, 90 rows, 85 with data, in 5 columns per group and organ. The columns are linked by exact arithmetic (section 5).

Still not stated anywhere we could read: separate exposure runs, randomisation, blinding, how many cuttings shared the coil, how far the controls stood from it, and where the leaves were when fluorescence was measured.

2 · THE EXPERIMENT

Four weeks in a coil, with controls on a bench

Cuttings stood in flasks of nutrient solution. One set stayed inside a three-axis coil that cancelled the local field; the other stayed in the local field. The authors call the field "the only intentionally manipulated experimental variable" [1 p. 2].

The setup, as the paper gives it

ITEM	WHAT THE PAPER SAYS	WHAT IT LEAVES UNSTATED
Plants	*Mentha longifolia* cuttings from a nursery in Piedmont, at the fourth leaf pair, in flasks with 500 mL of nutrient solution [1 p. 2]	How many mother plants; whether the solution was aerated or changed
Field	About 30 nT, from about 43 µT, in a triaxial Helmholtz coil, with a three-axis magnetometer "at the geometric center of the coil assembly" [1 p. 2]	A spread or stability figure; a map of the field across the plants
Exposure	Four weeks, under a 510 µmol m^{-2} s^{-1} LED lamp, 16:8 h, at 22 ± 1.5 °C. "Growth conditions were otherwise identical between the two groups", and "temperature, and light conditions were maintained constant across treatments" [1 p. 2]	Separate readings of light and temperature at each group
Controls	"Control plants were maintained under unaltered GMF conditions." [1 p. 2] Fig. S1 shows them on a bench, with no coil visible in its narrow crop [1 Fig. S1]	A sham coil; the distance from the coil
Replicates	"at least three biologically independent replicates, each consisting of pooled material from ten plants" [1 p. 4]	Whether they come from separate exposures, and whether each SD is across separate cultivations or within one
Allocation	Plants were "assigned" to the two treatments [1 p. 2]	Randomisation; blinding

"Characterized in detail"

The paper says the coil "has been previously characterized in detail, including assessments of residual AC magnetic fields, temperature stability, and potential vibration-related artifacts", and that "No significant confounding effects attributable to the experimental setup were detected", citing a 2018 paper from the same lab [1 p. 2]. That paper's text says that 50 Hz levels at the coils and the controls "were similar", with no values, and that its controls stood "at a distance of 8 m" [3 §Plant Material]; its sham runs gave insignificant differences "(data not shown)" [3 §NNMF Generation System]. That was another species under other lights, and we read its text, not its supplement.

What a stricter control looks like

An Oxford group testing Arabidopsis used doubly wound coils carrying the same current, chose the exposure coil at random each time, and kept the experimenter blind [12 §2]. The Beijing mouse studies on our page on near-zero fields and the brain used double-wrapped coils too. This lab knows such tools: its 2018 paper reports sham runs and double-blind experiments [3 §NNMF Generation System], and its 2026 Arabidopsis paper sham transfers and fluorometer controls [4 p. 4]. None of this is reported for the mint.

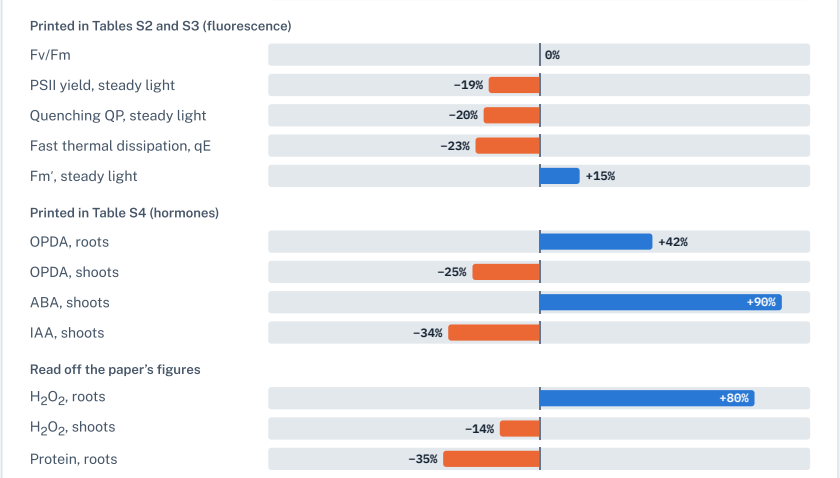
OUR ANALYSIS

By our estimate from the dimensions in Agliassa 2018, an ideal coil of that size leaves at worst about 100–180 nT at 10 cm from its centre and 550–790 nT at 20 cm, so "30 nT" is the value at the sensor and what each plant felt isn't reported [3 §NNMF Generation System]. The lab says the system "generates a homogeneous low-field region within the central experimental volume used for plant measurements", with no map [4 p. 15], and elsewhere gives its frame as about 2 m across [25 §Representative Results], which would lower these figures. That doesn't weaken the measured effects.

3 · THE RESULTS

Less oil, altered fluorescence, and hydrogen peroxide up in roots but down in shoots

The sizes are modest for pigments and oil and larger for some hormones and for root H_2O_2. Many numbers come only from the paper's figures, and we say which.



Our chart, from numbers in the paper and its supplement, CC BY 4.0 [1 Table 1][1 Tables S2–S4]; no figure is redrawn. The lowest group's values are our pixel readings of Figs. 2, 3 and 5, good to about two pixels; they reproduce the paper's own "~80%", "~35%", "~15%" and "~50%" [1 pp. 6, 9]. A bar's length says nothing about how firm a result is; see section 5.

The main readings, coil against control

MEASURE	COIL	CONTROL	P, OR THE PAPER'S MARK	WHERE
Total volatile oil, mg/kg dry weight	811.72 ± 25.38	1002.22 ± 97.26	0.030	Table 1
Carvone, mg/kg dry weight	353.36 ± 4.14	447.19 ± 35.31	0.010	Table 1
Carvone's share of the identified oil	63.45 ± 1.66%	65.57 ± 0.71%		Table 1
Fv/Fm, OJIP protocol	0.82 ± 0.01	0.82 ± 0.01	1.000	Table S2
Maximum yield, PAM protocol	0.83 ± 0.01	0.84 ± 0.01	0.174	Table S3
PSII yield in the light, steps L1 to Lss	0.13, 0.14, 0.17, 0.19, 0.22	0.20, 0.19, 0.22, 0.25, 0.27	0.001–0.032	Table S3
QP in the light, steps L1 to Lss	0.16, 0.18, 0.23, 0.28, 0.39	0.24, 0.24, 0.31, 0.36, 0.49	0.002–0.028	Table S3
NPQ in the light, steps L1 to Lss	0.05, 0.40, 0.74, 1.00, 1.15	0.06, 0.50, 0.91, 1.17, 1.30	0.064–0.437	Table S3
NPQ after dark, D2; D3	0.49 ± 0.08; 0.31 ± 0.06	0.37 ± 0.06; 0.21 ± 0.03	0.028; 0.017	Table S3
Fast thermal dissipation, NPQE; qE	0.84 ± 0.13; 0.36 ± 0.08	1.09 ± 0.15; 0.47 ± 0.04	0.015; 0.011	Table S3
Chlorophyll a; carotenoids, mg/g dry weight	4.83; 0.279	5.05; 0.339	asterisk on each	Read off Fig. 2
H_2O_2, roots; shoots, µM/g dry weight as plotted	19.4; 9.7	10.8; 11.4	asterisk on each	Read off Fig. 5B
Protein, roots; shoots, mg/g dry weight	3.98; 35.5	6.16; 35.1	asterisk on roots only	Read off Fig. 5A
Total phenolics, roots; shoots mg GAE/g	18.6; 34.0	39.1; 74.1	asterisk on each	Read off Fig. 3A
***IspG*; *GDPS* transcripts, log$_2$ change**	−2.80 (86% lower); −1.42 (about 63% lower)		***; **	Read off Fig. 1B
***SOD*; *CAT*; *APX*, roots, log$_2$ change**	−0.33 (20% lower); −0.22 (14% lower); −0.13 (9% lower)		asterisk on each	Read off Fig. 5C
***CHI*, shoots, log$_2$ change**	−0.45 (27% lower), which the text calls "pronounced" [1 p. 6]		asterisk	Read off Fig. 3D

Where the Results quote a different P from Table S3 (QP at Lss 0.024 against 0.016; QY D2 and D3 0.025 against 0.009 and 0.004; NPQE 0.012 against 0.015; QY L1–L4 "P ≤ 0.017" against up to 0.025), we give the table's [1 p. 5]. We take direction from the table too: NPQ is higher after dark, as the Results say, but not in the light, where Fig. 2J's asterisks have no P below 0.05 behind them in Table S3, and the colours of Fig. 2G–J run opposite to the figure's legend. "Total phenolics" is a Folin–Ciocalteu reading, and that reagent also reacts with proteins, thiols and some vitamins [34 Abstract].

4 · "STRESS"

No growth, survival or damage was measured; "stress" rests on changed markers

A search of the paper finds no measure of growth, biomass, height, leaf area or survival, and no report of plants dying or stunting [1]. Whether a plant grew less can't be told from it. The lab did measure growth in other species (section 9).

What wasn't measured

Beyond growth: gas exchange, CO_2 uptake and ATP, so the abstract's "photosynthetic energy deficit" is an inference; lipid peroxidation, electrolyte leakage and protein carbonyls, the usual signs of oxidative damage; the activities of the antioxidant enzymes, as against their transcripts; and IspG protein, its activity and Fe-S clusters [1 pp. 2–4][1 p. 9]. The methods give no protocol for total protein, though root protein is a headline result [1 Fig. 5A].

What points away from damage

Fv/Fm, a common measure of lasting harm to PSII, is 0.82 in both groups [1 Table S2], close to the 0.83 of unstressed leaves, a figure measured at 77 K in C3 species [33 Abstract]. The authors write that "the core photochemical efficiency of PSII remained stable" and that the response "appears to be dynamic rather than destructive" [1 p. 5][1 p. 10]. Shoot protein didn't change, and shoot H_2O_2 fell [1 p. 9].

How the wording moves through the paper

WHERE	THE WORDS
Title	"induces abiotic stress … through coordinated changes" [1 p. 1]
Abstract	"was associated with a stress response", but also "causing a ~50% reduction" and "resulting in reduced essential oil production" [1 p. 1]
Discussion	"imposes a distinct physiological stress", then "dynamic rather than destructive" [1 p. 10]
Conclusions	"is associated with a multi-level abiotic stress" [1 p. 11]; "does not directly demonstrate mechanistic relationships" [1 p. 12]
Fig. 6	"ultimately producing a phenotype of reduced overall plant performance", in a "conceptual framework" [1 p. 12]

In the authors' words

NNMF is their near-null magnetic field.

> *"the proposed relationship between geomagnetic field reduction, Fe-S cluster homeostasis, and MEP pathway regulation should be regarded as a hypothesis requiring direct experimental validation"*
>
> Mannino et al. (2026) [1 pp. 9–10]

> *"the present study cannot establish whether root oxidative stress causally influences shoot monoterpene metabolism"*
>
> Mannino et al. (2026) [1 p. 11]

> *"A dedicated matrix spike-recovery test was not performed, and possible matrix-related interference therefore cannot be completely excluded"*
>
> Mannino et al. (2026), of the H_2O_2 assay [1 p. 3]

OUR ANALYSIS

Why "induces" goes too far, and what stays

Some markers do fit a stress response: shoot ABA up 90%, root OPDA up 42%, more quenching left after dark, lower PSII yield in the light [1 Table S3][1 Table S4]. The paper's body hedges with care. The title doesn't, and it adds a mechanism, "through coordinated changes", that the conclusions say wasn't shown; Fig. 6's "reduced overall plant performance" has no measure of growth or yield behind it; the paper's own measures of "Plant performance" are PSII efficiency and flavonoid distribution [1 p. 2]. Set against that are an unchanged Fv/Fm, no measure of growth or damage, a fall in shoot H_2O_2, and a design that can't separate the field from the place (section 5). The matrix caveat matters too, because the two groups' root extracts differ: phenolics were about half as high in the coil roots whose peroxide reading rose [1 Fig. 3A]. So we rate the title Overstated, and the root claim Partly true.

5 · THE NUMBERS

The printed groups differ; the design can't say why, and one file can't show its replicates are separate

The paper applies no correction for multiple tests, and says "the relatively large number of variables examined may increase the likelihood of Type I errors", so "individual metabolite changes should be interpreted with caution" [1 p. 4][1 p. 11]. So we ran one, from the printed numbers and the workbook, with rules written first.

FLAGGED, ALL TOLD
OUR ANALYSIS

99 of 178

comparisons in the paper and supplement, where about 9 would arise by chance. Our count, by eye for figure panels. It leaves out tests per flavonoid, which the paper doesn't report, and 23 of the 99 (Fig. 3H–K) rest on the flavonoid file below. Without them: 76 of 140, about 7 by chance

OIL, TABLE 1
OUR ANALYSIS

0 of 24

rows survive Benjamini–Hochberg at q = 0.05. The smallest P is 0.009 and the first threshold 0.0021. That is mostly what n = 3 does: the table can't stand alone, which isn't to say the oil didn't fall. Counted post hoc as just the two outcomes the abstract names, total oil and carvone stay below 0.05 under Student's t (Holm 0.030 and 0.020), though not under Welch's

OJIP, TABLE S2
OUR ANALYSIS

2 of 26

below P = 0.05, where chance alone gives 1.3, and neither survives. The Discussion still reads them as "a restricted electron acceptor pool (Sₐ)" offset by faster turnover [1 p. 10]

Every set of tests, as printed and after correction

SET	N	TESTS	P < 0.05	BY CHANCE	SURVIVE BH	SURVIVE HOLM
Table 1, oil	3, printed	24	8	1.2	0	0
Table S2, OJIP	4 and 7, from the decimals	26	2	1.3	0	0
Table S3, PAM	4 and 6, from the decimals	39	26	2.0	22	3
Table S4, hormones	3, in its note	18	12 by asterisk; 8 recomputed	0.9	4	4
Data Set S1, flavonoids	5, in its heading	162	95	not meaningful	not meaningful	not meaningful

BH is Benjamini–Hochberg at q = 0.05; Holm is at 0.05. Printed P values for Tables 1, S2 and S3; recomputed from printed means and SDs for Table S4 at n = 3; Student's t on the workbook's columns for Data Set S1, which assumes they are independent (below). On those columns the count can't be read against chance: keep the sample-1 columns, redraw every multiplier within its limits, and it stays 94.5 ± 5.2 of 162 (range 76–111, 2,000 draws), because each test in effect compares two sample-1 values. Our analysis. Under Welch's t on Table 1, carvone's P goes from 0.010 to 0.042 and total oil's from 0.030 to 0.069.

The n, as far as it can be told

Tables S2 and S3 print no n. Their raw fluorescence means come in quarters in the control column, and in sevenths in Table S2 and sixths in Table S3 in the coil column, which is what 4 against 7 and 4 against 6 whole-number readings give [1 Tables S2–S3]. Recomputed at those n, all 22 of Table S2's testable rows and 36 of Table S3's 39 fall on the same side of 0.05 as printed (our analysis). So the two groups appear unequal in size in these tables, and fluorescence was read on intact leaves, not on the pools of ten plants [1 p. 3]. A fit to the printed P values alone preferred equal groups (6 and 6 in Table S2, 5 and 5 in Table S3), so it is the decimals that decide.

Table S4's asterisks

Its note says n = 3, while Fig. 4A's heatmap has five columns per group [1 Table S4][1 Fig. 4A]. Recomputed from the printed means and SDs at n = 3, 8 of the 12 asterisks reproduce; at n = 5, 11 do. Root SA, at 1.84 ± 0.06 against 3.68 ± 2.00, reproduces at neither (P = 0.19 and 0.074), though the abstract says "reduced SA levels in both organs" [1 p. 1] (our analysis).

Data Set S1: what its numbers can show

The file's five columns per group are linked by exact arithmetic, so it can't show five independent measurements. It can't show why, and an innocent slip in preparing it is one possibility.

The workbook has 90 rows of flavonoid peak areas, 85 with data, given as "total area in each one of the different biological replicates (N=5)" [1 Data Set S1]. In all four groups, treatment by organ, these relations reproduce digit for digit at the file's 10 significant figures (our analysis):

Arithmetic that holds in the file, all four groups together

RELATION	ROWS WHERE IT HOLDS	RANGE OF THE MULTIPLIER
Sample 2 = sample 1 × a number with at most 3 decimals	320 of 320 non-zero rows	0.70–1.40
1.5 × sample 3 = sample 1 × a number with at most 3 decimals	320 of 320	1.10–1.60
Sample 4 = sample 2 × a number with at most 4 decimals	320 of 320	0.70–1.40
Sample 5 = mean of samples 1–4 × a number with at most 3 decimals	320 of 320	0.90–1.10
Sample 1 is a whole number	320 of 320; in samples 2–5, 9 of 1,280 non-zero values	
Where sample 1 is zero, all five are zero	40 of 40; no other sample is zero	
Checks: sample 5 on sample 1; sample 4 on sample 1; sample 3 on sample 2	0, 1 and 1 of 320	
Check: sample 1 across groups, at up to 4 decimals	0 in every pairing	

Take the first row, apigenin in control shoots: sample 1 is 652,398; sample 2 is sample 1 × 0.92; sample 3 is sample 1 × 1.286 ÷ 1.5; sample 4 is sample 2 × 1.1749; sample 5 is the mean of the first four × 0.908. For unrelated numbers, a chance match has a probability of about 3 in a million per row at 3 decimals, and about 3 in 100,000 at 4. The two single matches in the checks are products of the chain, not chance hits (1.328 × 1.375 = 1.826; 1.122 × 1.5 = 1.36 × 0.55). Our analysis of the workbook; these rules were written after we had noticed the decimals, and the rules files say so.

OUR ANALYSIS

What this can and can't show

On these figures, samples 2–5 of a row add at most one short multiplier each to sample 1: worked as one chain and rounded to the file's 10 significant figures, all 1,280 values come out digit for digit. The workbook holds plain numbers, no formulas, so it doesn't show where that working was done. So the file can't show five independent measurements, and the tests in the table above assume what it can't show, and so would any clustering built on them. The four sample-1 columns aren't linked to each other in this way, and the multipliers don't repeat across groups, so the link runs within a group, not across groups.

The arithmetic doesn't say why, and it says nothing about anyone's intent. It does set aside some routine causes: normalising multiplies a whole column by one number, and here the multiplier changes from row to row; instrument software works on each injection by itself; filling gaps touches some cells, not four columns of every row; and a spreadsheet's way of storing numbers can't make short multipliers. Other explanations stay open, and some would be innocent: a template, test or earlier working table uploaded in place of the real one, or columns filled in while the workbook was being laid out and never replaced. In that case the real measurements could be separate and sound, and our tests on this file would say nothing about them. The paper describes no such step. Only the authors can say, with their raw chromatograms, and we have not put this to them. All of this covers this file only: the paper's other measures have no per-sample data in the supplement, and "Data will be made available on request" [1 p. 12].

We couldn't confirm that Fig. 3 was drawn from these exact numbers. Its heatmap has the file's 85 non-empty rows and the same broad pattern, so the file belongs to this study, but its cells, as we read their colours, don't match the file's columns, its PCA plots four points per group against five, and no processing we tried gives its printed percentages (our analysis). Found after our rules, by our reviewer: the second sheet shows a plain spreadsheet slip, its UV column's second value rising by exactly 1 nm a row, as dragging a cell down would make it.

Taking the file as it stands, most of the paper's statements on flavonoid classes hold in direction, on our reading of "relative abundance" as a class's share of each sample's total: 14 of 18 [1 pp. 6–8]. The summed peak area, though, runs the other way from the paper's flavonoid assay: 32% higher in coil shoots and 10% higher in coil roots, against an assay reading 17% and 22% lower [1 Fig. 3B]. Peak areas of different compounds aren't concentrations, so that sum isn't a total content, but it sits awkwardly with "the suppression of flavonoid pools" [1 p. 6] and "Beyond reducing total metabolite abundance" [1 p. 11]. In effect that sum compares two sample-1 columns, the root figures aren't significant on either side, and if this isn't the authors' working table the comparison says nothing about their flavonoids.

OUR ANALYSIS

So the main weakness is the design

Taking the printed numbers as measured, the count is far above chance, even without those 23, so on the printed numbers these two sets of plants differed. The question is why. The paper describes one coil and one set of controls on a bench. If all the coil plants shared one exposure, there is one unit per treatment, and pools inside it are subsamples: the classic pseudoreplication [32]. In 2018 the same lab wrote "the experiments were repeated three times (biological replicates)" [3 §Statistical Analyses]; this paper doesn't say that, and "biologically independent" doesn't settle it. A difference between one coil and one other place is what any effect of the place would also produce, across many correlated measures at once. The paper doesn't show that this happened, and it doesn't rule it out.

6 · TEN SECONDS

The same lab gets some of these fluorescence changes after 10 seconds in this coil, and the opposite in others

Weeks before the mint paper, the lab reported that Arabidopsis leaves change their fluorescence within 10 seconds of entering the ~30 nT field of the same coil system, measured there with the same model of fluorometer [4 p. 15]. The mint paper doesn't say where its leaves were measured [1 p. 3].

Ten seconds in Arabidopsis beside four weeks in mint

READING	ARABIDOPSIS, 10 SECONDS [4 P. 4]	MINT, FOUR WEEKS [1 TABLE S3]
Amplitudes, OJIP	"significant increases in the absolute fluorescence amplitudes"	No change: Fm 0.9% higher (P = 0.720) [1 Table S2]
Amplitudes, PAM	Not given in its text	Fm′ 8–18% higher (P = 0.0002–0.021); Fm 7.5% higher (P = 0.058)
Fv/Fm	"remained unchanged"	Unchanged (0.83 against 0.84, P = 0.174)
PSII yield in the light	Lower at the first light step	Lower at every step
Photochemical quenching	Lower at the first light step	Lower at every step
NPQ in the light	Higher	Lower at all five steps, though not significantly (P = 0.064–0.437)
Fast thermal dissipation, NPQE	About doubled, 0.79 against 0.38 [4 p. 7]	Lower, 0.84 against 1.09 (P = 0.015)

The Arabidopsis paper is on the journal's site as an unedited "Article in Press"; its article page still gives only the abstract, and we quote the unedited PDF. Its authors found only small effects in chlorophyll extracts and dead leaves, estimated at "generally below 5% for Fm and Fv" of the response, and nothing in sham transfers [4 p. 4].

OUR ANALYSIS

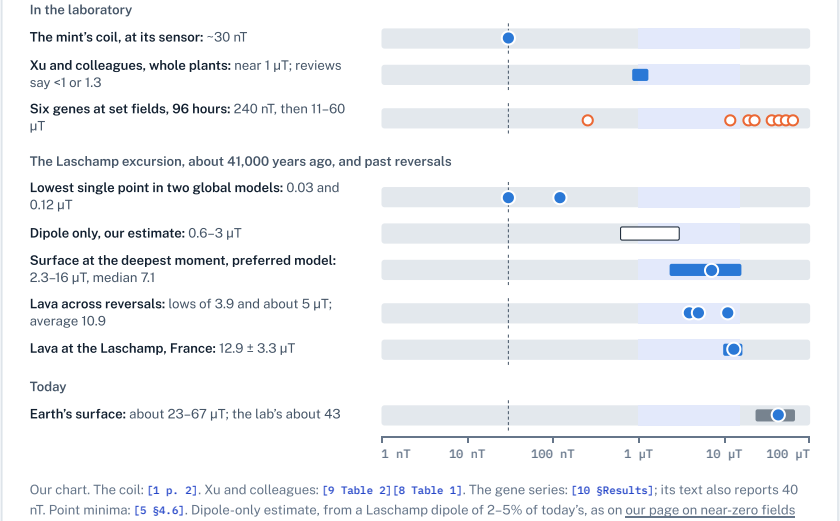
A question, not a finding

If the mint's leaves were measured inside the coil, the fluorescence differences could be an immediate effect of the field at the moment of measuring, not a record of four weeks' stress. If they were carried out to the local field first, a transition happened on the way, and the lab's own work says transitions matter. Either way, the mint's fluorescence can't simply be read as accumulated harm. We can't choose between these from what's printed. The flat OJIP amplitudes and the opposite NPQE count against reading the mint's fluorescence as only the 10-second effect. Oil, phenolics and H_2O_2 don't have this problem.

7 · A REVERSAL IN A COIL?

The coil goes far below any measured low of Earth's field we found, so it can't stand in for a reversal

In the preferred global model of the Laschamp excursion, the typical surface field at its deepest moment was about 7 µT, some 240 times the coil's (our analysis) [6]. The paper names no reversal or excursion: a search of its full text finds no pole, excursion, polarity, secular or dipole, and "reversal" only in the title of a cited paper [1 p. 12][25]. Its nearest sentences are general: "Alterations in GMF intensity (Paponov et al., 2021) or vector orientation (Bertea et al., 2015) have been shown to trigger stress responses in plants" [1 p. 2], and the findings "further support the view that geomagnetic field variations can contribute to the regulation of plant physiological processes" [1 p. 12]. The experiment has two conditions and no variation in between.



Our chart. The coil: [1 p. 2]. Xu and colleagues: [9 Table 2][8 Table 1]. The gene series: [10 §Results]; its text also reports 40 nT. Point minima: [5 §4.6]. Dipole-only estimate, from a Laschamp dipole of 2–5% of today's, as on our page on near-zero fields and the brain [5 §4.2][37 §3]. The surface at the deepest moment: our run of LSMOD.2 [6], 5th to 95th percentile by area at 41.02 thousand years ago. Lava: La Palma [30 Abstract], Steens Mountain [29 Abstract], France [31 Abstract]. Today: [35 Table 1].

What a real low reaches

In a reversal the surface field falls to "about 10% of its current value" [38 Abstract]. Lava that cooled during reversals reads as low as 3.9 µT at La Palma and about 5 µT at Steens Mountain, with a transitional average there of 10.9 ± 4.9 µT [30 Abstract][29 Abstract]. At the Laschamp excursion, about 41,000 years ago (our review of the record), the dipole fell to about 2–5% of today's [5 §4.2][37 §3], but the rest of the field remained: lava in France from that time reads 12.9 ± 3.3 µT [31 Abstract].

The point minimum, in the modellers' words

Korte and colleagues write that in the middle of the Laschamp intensity is weak all over the globe, "with minimum values at the Earth's surface <1µT in all cases, as low as 0.03 µT in model A and 0.12 µT in preferred model C" [5 §4.6]. So one model variant touches the coil's field, at a point, and the preferred model's published low is four times it. A model built from smoothed sediment records can't say where such a point was or how deep [5 §2.2.2].

The preferred model of the Laschamp, 44,000–38,000 years ago

FIELD BELOW	SHARE OF EARTH'S SURFACE EVER THERE	LARGEST SHARE AT ONE MOMENT	LONGEST UNBROKEN SPELL AT ONE PLACE
30 nT	Under 0.01%, a handful of cells	Under 0.01%	Years, indicative only
100 nT	0.036%	0.007%	20 years
300 nT	0.45%	0.09%	50 years
1 µT	5.3%	0.95%	210 years
5 µT	69%	25%	940 years
10 µT	90%	76%	

Our analysis of LSMOD.2 [6], degree 10, 1° cells weighted by area, every 10 years, with rules written first. Our run reproduces the model's lowest dipole moment, 3.67 against Korte's 3.7 ZAm². It doesn't match Korte's 0.12 µT to its digits: our lowest values per decade near the excursion's middle, about 40.6 thousand years ago, scatter from 29 to 910 nT, and the epoch and grid aren't stated. Our rule said such numbers wouldn't be used; we kept the areas, which don't rest on the point minimum, and say so. We cite Korte for the point minimum and treat our own point values as indicative. Rows from 1 µT up are steady; the two lowest grow two to four times at yearly steps.

OUR ANALYSIS

How the coil compares

No measured record we found comes near 30 nT; one model variant touches it at a point [5 §4.6], and our run of the preferred model dips below it only at moving points, for a few years at most in any one place. At the Laschamp's deepest moment the typical surface field in that model was about 7 µT, about 240 times the coil's, and more than 99.9% of the surface never went below 100 nT. At the Turin lab's own location the model's lowest is 3.2 µT, about 106 times the coil's. Long exposure isn't what's missing, since a place could sit under 5 µT for centuries. Strength and area are.

Today's surface field is about 23–67 µT, 770–2,200 times the coil's [35 Table 1], and the dipole is about 9% weaker than in 1840 [36 p. 1]; no excursion is expected for centuries (our page on the next excursion). The field 30 nT does resemble is off Earth: 2–8 nT in interstellar space, 9–300 nT on the Moon and 10 nT–5 µT on Mars, as a review from another lab lists them [42 §1]. The lab's fluorescence paper says its protocol "was not intended to reproduce naturally occurring GMF fluctuations" [4 p. 9].

8 · THE FAIR CASE

Near 1 µT, independent work reports less seed; from 1 to 15 µT, growth and yield are close to untested

This is the strongest evidence we found that a reversal's weaker field could affect plants. We found no test of what a real reversal's field does to plants over a life cycle, in either direction.

Xu and colleagues: Arabidopsis near 1 µT

A group in Beijing grew Arabidopsis for its whole life in a near-null field, and reports biomass suppressed around the switch to flowering, about 22% fewer siliques, about 19% less seed and about 20% lower harvest index [7 Abstract]. In later work from the group, the flowering delay is absent in mutants lacking two cryptochromes [44 Abstract], a link a 2012 paper's title had already drawn [43 Title]. That is growth and yield, the very thing the mint paper didn't measure, from a lab independent of Turin's. Its field lies a little below the 2.3–16 µT most of the surface saw at the Laschamp's deepest moment, and about 5% of the surface went below 1 µT at some time in that model (our analysis) [6].

Two cautions. The two reviews differ on the field value: one lists under 1 µT [9 Table 2], the other 1,300 nT [8 Table 1]. And we read the paper only as an abstract: Wiley's site refused our tools when we tried a later paper by the group. It is one species, in a laboratory, for one lifetime.

Flowering, and gene readings at set fields

Delayed flowering in Arabidopsis near-null fields has been reported by two labs: Xu's, and Turin's, at about 40 nT, by about 4–5 days [7 Abstract][3 §Results]. Turin also set seven fields from 240 nT to 60 µT, beside controls at 41 µT, for 96 hours and read six genes, five of which responded in a biphasic way, some changing direction between 11 and 18 µT [10 §Results]. A Marburg group's curves for four transcripts, from near zero to 188 µT, show several maxima [11 Abstract]. These hint that plants can register fields a reversal might bring. But the Turin authors add that "the biphasic responses for individual genes do not necessary reflect the growth responses of plants", and that an optimum might sit near 30 µT, a field some regions have today [10 §Discussion].

OUR ANALYSIS

Not shown, and not ruled out

Across all organisms, an analytical review found that "There is no statistically significant correlation of the effect size with the HMF value or the exposure time" [8 §Results], and a later one that "The vast majority of biological effects in HMCC occur at inductions below 300 nT" [9 §7]. Of the 22 rows on plants or plant tissue in the first review's table, 16 are at 500 nT or below and 6 at 0.8–2 µT [8 Table 1]. Neither table holds a whole-plant experiment between 2 µT and the local field, though both reviews selected weak-field work by design, and our own search wasn't exhaustive. So growth and yield over a life cycle at about 1–15 µT, the field a real reversal or excursion would bring to most places, are close to untested. The nearest test, Oxford's 72-hour seedlings at 0 ± 10 µT against 50 µT, found no significant difference in hypocotyl length [12 §3.4]. The evidence doesn't show that a reversal's field harms plants, and it doesn't show that it can't.

9 · OTHER PLANTS, OTHER LABS

In one lab's coils, the direction changes from species to species

The Turin lab has run this kind of coil on at least eight species. They agree on some things, not on others. In its own words of 2018, the wider field shows "a large number of conflicting reports", and "Many experiments are simply unrealistic, while others lack a testable hypothesis and, ultimately, prove not to be reproducible" [3 §Introduction].

Same lab, same kind of coil

SPECIES	H_2O_2	OIL OR TERPENES	PIGMENTS, PHOTOSYNTHESIS, GROWTH	WE READ
Wild mint [1]	Roots +80%, shoots about −15%	Oil −19%, pathway genes down	Chl a −4%, carotenoids −18%; no growth measure	Full text
Peppermint [15]	Lower	Menthol lower, pathway genes up	PSII efficiency lower; maximum yield unchanged	Abstract
Basil [16]	Lower	Oil higher; eugenol and methyl eugenol up 1.3- and 1.8-fold, pathway genes down	Chl b up; NPQ capacity markedly lower	Abstract
Arabidopsis [13]	Lower, in roots and shoots			Full text
Lima bean [14]	Lower		Chlorophyll and RubisCO lower; leaf area lower	Full text
Maize [19]	Roots higher, shoots unchanged		Chlorophyll higher; root length and root protein lower; phenolics unchanged	Full text
Tomato [17]	Not in the abstract		Chlorophyll, carotenoids and efficiency lower; NPQ higher	Abstract
Lettuce [18]	Changed; direction not in the abstract		Chlorophyll lower; root form altered	Abstract

Abstracts came through indexes, so we paraphrase them. Exposures differ, from days to weeks, so this isn't one experiment repeated.

OUR ANALYSIS

What the table shows

Direction varies even inside one lab, and the mint paper itself says "the generality of these responses should be evaluated in additional species" [1 p. 12]. Falling transcripts went with less oil in the mint, rising transcripts with less menthol in peppermint, and falling phenylpropanoid transcripts with more oil in basil, so transcripts alone don't predict oil across these plants; of the link it explores, the mint paper itself says that "transcriptional downregulation of IspG does not necessarily indicate impaired Fe-S cluster assembly or reduced IspG enzymatic activity" [1 p. 9]. Root H_2O_2 and root protein are matched in maize, a genuine point of agreement. The senior author's 2025 review says that a hypomagnetic field directly lowers reactive oxygen and that the plant then perceives less oxidative stress, which sits awkwardly with "oxidative stress" here [20 Abstract]. And the lab's own maize paper concludes that survival depends on regolith's chemistry "rather than reduced gravity or lack of magnetic field" [19 Title].

Other labs

The mint specifically: we found no independent repeat. **Germination:** a 2026 preprint, not peer reviewed, finds Arabidopsis seeds slower to germinate, with no loss in final rate and with reactive oxygen up, the opposite direction from Turin's seedlings [21 Abstract]. **Potato:** near-null fields gave either stimulation or inhibition, varying with exposure and geomagnetic activity [22 Abstract]. **A null nearby:** an Oxford group testing cryptochrome claims with zero-field (0 ± 10 µT) controls reports "In no case were consistent, statistically significant magnetic field responses detected" [12 Abstract]; that is much less strict than 30 nT. **Reviews:** "Each work reviewed is unique and, therefore, not replicated by an independent scientific group" [8 §Results]; "The effects of HMC are poorly reproduced" [9 §5]. That first review also says "As over 95% of the studies referenced in Table 1 report significant effects of HMF, this biological effect is very well established but the mechanism remains unknown", and notes that studies finding nothing may go unpublished.

10 · PLANTS THROUGH REVERSALS

The lab's reversal argument is real; the mint paper doesn't make it

A link between near-zero fields and reversals has been drawn before: the mint paper's senior author made it in earlier work, and it deserves a fair weighing. The mint paper itself says nothing of it.

In the lab's earlier words

The 2014 quotations are from the accepted manuscript in the University of Turin's repository, not the published version.

> *"Because the strength of the GMF is strongly reduced during polarity transitions, when compared to stable normal or reversed polarities, we propose that these variations might be correlated to plant evolution."*
>
> Occhipinti, De Santis and Maffei (2014), accepted manuscript [23 p. 4]

> *"an imminent geomagnetic reversal would not be so unexpected"*
>
> Occhipinti, De Santis and Maffei (2014), accepted manuscript [23 p. 2]

> *"Reversal of the GMF implies a period of transition that may expose living organisms to NNMF."*
>
> Agliassa et al. (2018) [3 §Introduction]

What the argument rests on

A short Spotlight piece compares a polarity timescale with when angiosperm lineages diverged: "We found that the periods of normal polarity transitions overlapped with the diversion of most of the familial Angiosperm lineages". It closes by asking "Do geological variations of GMF have a role in plant evolution?" [23 pp. 4–5]. In 2015 the lab flipped the field's direction at full strength in its coil, with sham runs, for 10 days, found shorter roots and changed genes, and called this "a compelling evidence" for the hypothesis [25 §Discussion]. The mint paper cites that work only as "vector orientation" [1 p. 2].

OUR ANALYSIS

What weighs against it

No test against chance. The evidence is an overlap on a figure, with reversals about five times per million years in recent times [26 §5] and divergence dates whose timescale is far from settled [28 Abstract]. **It points at stability.** The figure's own legend says "most of the diversion occurred during periods of normal magnetic polarity" [23 p. 6][24 Fig. 2]. The Cretaceous Normal Superchron, 83–125 million years ago [26 §1], had no reversal for about 40 million years, and overlaps the angiosperms' rise, whose oldest fossils date to 130–136 million years ago [23 p. 4] and whose great expansion ran from about 100 to 50 million years ago [27 Abstract]. **A coil flip isn't a reversal.** In nature the direction takes thousands of years to change, with the field weak (our guide).

The same lab, later

In 2021 a paper with the same senior author wrote: "At present, no evidence exists to indicate any evolutionary advantage of plant adaptation to the GMF; however, plants can sense and respond to the GMF using the signaling networks involved in stress responses" [10 Abstract], and that "plants presumably had no need to evolve mechanisms for quick responses to MF changes" [10 §Discussion]. The 2014 piece's extrapolation "would predict a GMF reversal in less than 1000 years" [23 p. 2]; our page on the next excursion finds no excursion likely for at least the next few centuries, and no date beyond that.

The wider record

A 2010 review finds "no clear picture of a geomagnetic link" [38 Abstract]. Asked whether reversals endanger life, the British Geological Survey answers "Almost certainly not" [39]. A 2021 paper tying the Laschamp to climate shifts and extinctions drew formal comments [40][41]. We found no vegetation record tested against a reversal or excursion, in a limited search. New Zealand's kauri trees lived across the Laschamp, and their wood is part of that 2021 paper's record [40 Abstract]; a survivor is no test of stress.

11 · REPEAT OUR NUMBERS

The scripts, the rules and their outputs

Rules came before each first run; where we had already seen something, the rules say so. Our later additions follow a fresh review of this page, and their rules say that too. A fresh run of the Laschamp script, downloading the model again, and of the other scripts in an empty folder, gave the same outputs byte for byte.

PY **recheck_dataset_s1.py**
Data Set S1: the tests, the class shares, the arithmetic between columns, the exact chain, and the tests with the multipliers redrawn; needs numpy and a copy of the journal's workbook · 21 KB

JSON **recheck_dataset_s1.json**
Its output · 16 KB

PY **fig3_compare.py**
Fig. 3E's cells, read against its colour bar, compared with the workbook, and PCA under 81 variants; needs numpy, scipy, Pillow and the workbook · 12 KB

JSON **fig3_compare.json**
Its output · 2 KB

PY **recheck_tables.py**
Tables S2–S4: the n, the tests and the corrections, with its rules in its docstring; plain Python · 14 KB

JSON **recheck_tables.json**
Its output · 19 KB

PY **recheck_stats.py**
Table 1's tests, the corrections and our tally; plain Python · 11 KB

JSON **recheck_stats.json**
Its output · 9 KB

PY **lsmod2_surface.py**
Downloads LSMOD.2 from GFZ Data Services, checks its hash, and computes the surface field, every 10 years, and with --fine, at finer sampling; needs numpy · 19 KB

JSON **lsmod2_surface.json**
Its output: areas, spells, sites, the validation · 19 KB

JSON **lsmod2_sampling.json**
Its output at yearly steps on 1° cells and 2-year steps on 0.5° cells · 3 KB

TSV **lsmod2_decades.tsv**
Its output, decade by decade, derived numbers only · 27 KB

PY **coil_uniformity.py**
Our estimate of an ideal coil's field away from its centre; needs numpy · 6 KB

JSON **coil_uniformity.json**
Its output · 6 KB

PY **figure_values.py**
Reads the paper's bars by pixels, from images taken out of its PDF by extract_pdf_images.py; both need Pillow · 8 KB and 3 KB

JSON **figure_values.json**
Its output: every value we read off a figure · 6 KB

TXT **RULES_supplement.txt**
The rules for the supplement's re-run, what we had seen when we wrote them, and an addendum · 5 KB

TXT **RULES_review_addendum_s1.txt**
The further rules for Data Set S1, written after the review · 4 KB

TXT **rules_sha256.txt**
The hashes of those two files, with times · 1 KB

TXT **RULES_table1_lsmod2_coil.txt**
The rules for the other runs, copied from the scripts' docstrings, where they were written before each first run, with no hash recorded then · 11 KB

TXT **RULES_review_addendum.txt**
The rules for what we re-derived after the review; they say plainly that they follow it · 3 KB

TXT **rules_sha256_review.txt**
That file's hash, with its time · 1 KB

Run it

`py -3.12 -I lsmod2_surface.py <folder> --fine` fetches about 0.5 MB and writes its outputs there, in a few minutes; any Python with numpy will do. `python3 -I recheck_tables.py <folder>` and `python3 -I recheck_stats.py <file.json>` need nothing else, and `py -3.12 -I coil_uniformity.py <file.json>` only numpy. `py -3.12 -I recheck_dataset_s1.py <mmc1.xlsx> <folder>` and `fig3_compare.py` need the journal's workbook, from the article's page, which we don't host.

The data and their terms

LSMOD.2: Korte and Brown, GFZ Data Services, CC BY 4.0, the code Apache 2.0; we host derived numbers and fetch the rest by URL [6]. **The paper and supplement:** CC BY 4.0, with credit to Mannino, Caldo and Maffei [1 p. 1]; we redraw no figure and chart numbers only.

12 · LIMITS

What this check could and couldn't see

What only the authors know

Separate runs, randomisation, blinding, where leaves were measured, how Data Set S1's columns came about, and what each SD spans. Per-sample data for the other measures are on request [1 p. 12]; we haven't asked for them.

Papers read as abstracts

Xu and colleagues, the peppermint, basil, tomato and lettuce papers, and others, as the list marks. Publishers refused our tools for some. Xu's field value rests on two reviews that differ.

Field models

A model truncated at degree 10, from smoothed records, can't resolve small-scale field. Our areas are a rough guide to one excursion's preferred model, not a measurement at any place [5 §2.2.2].

Readings off figures

Good to about two pixels. They match the paper's printed percentages where both exist, but those figures' raw values aren't in the supplement [1 Figs. 1–5].

Our own re-runs

Our principal-component runs on Data Set S1 didn't reproduce the percentages printed for Fig. 3F, and the paper doesn't give every processing step. So we say only that we couldn't confirm the figure came from these numbers [1 p. 6].

A limited search

"We found no" and "we found" mean in the indexes and reviews we searched. A vegetation record through a reversal, or a whole-plant study at 1–15 µT, may exist that we missed.

What would change these verdicts

01
A repeat of the mint result with sham coils, blinding, randomised positions and separate runs, ideally in another lab, with growth measured. That could move "Less essential oil and carvone" to True and "Near-null field induces stress" closer to it.

02
An explanation of Data Set S1's columns from the authors, with the chromatograms, or the study's other per-sample data.

What a reversal would do to plants turns on a different test: a whole-plant experiment at 1–15 µT, with growth and yield measured, or a tested plant record through a reversal or excursion (section 7 and section 8).

Sources

Bracketed numbers refer to this list. For the paper [1], read in full with its supplement, p. gives a page of the journal's PDF, Fig. and Table a figure or table, and Fig. S1, Tables S1–S4 and Data Set S1 the supplement; values we read off its figures say so. For the other sources, p. gives a page of the copy named in the entry, § a section, Fig. a figure, Table a table, and Abstract or Title that part of the cited work; where only an abstract was read, the entry says so. nT is the nanotesla and µT the microtesla, 1,000 nT; GMF is the geomagnetic field and NNMF the near-null magnetic field, in the authors' terms. Years are those of the printed issue where there is one, otherwise of online publication. Publishers' hyphen characters are printed as ordinary hyphens. Links checked November 4, 2026.

1 Mannino, G., Caldo, F., and Maffei, M. E. (2026). Geomagnetic field reduction induces abiotic stress in *Mentha longifolia* through coordinated changes in photosynthesis, phytohormone networks, flavonoids and essential oil biosynthesis. *Plant Stress* 24, 101593. Received August 10, 2026, revised October 9, accepted October 26, online October 28. Peer reviewed. CC BY 4.0. Full text and supplement (Fig. S1, Tables S1–S4, and Data Set S1, a workbook): ScienceDirect refused our tools, so the site's owner downloaded the PDF, the supplement's PDF and the workbook on November 4, 2026.

2 SpaceWeatherNews (S0) (November 3, 2026). Pole Shift Hits Plants, EM Solver Update | S0 News Nov.3.2026. YouTube video, https://www.youtube.com/watch?v=gtstJYYBKxo. No transcript was available.

3 Agliassa, C., Narayana, R., Bertea, C. M., Rodgers, C. T., and Maffei, M. E. (2018). Reduction of the geomagnetic field delays *Arabidopsis thaliana* flowering time through downregulation of flowering-related genes. *Bioelectromagnetics* 39(5), 361–374. CC BY 4.0. Full text, through Europe PMC, without its supplement; the mint paper's reference for the coil.

4 Olmo, A., Kanchiswamy, C. N., and Maffei, M. E. (2026). Near-null magnetic fields modulate photosystem II function and electron transport in *Arabidopsis thaliana*. *Scientific Reports*, online October 8, 2026. CC BY 4.0. Unedited: on November 4, 2026, the journal's article page still flagged it as an unedited manuscript and gave only the abstract, so we quote the unedited "Article in Press" PDF, and p. gives its page.

5 Korte, M., Brown, M. C., Panovska, S., and Wardinski, I. (2019). Robust characteristics of the Laschamp and Mono Lake geomagnetic excursions: results from global field models. *Frontiers in Earth Science* 7, 86. CC BY 4.0. Full text.

6 Korte, M., and Brown, M. (2019). LSMOD.2 – Global paleomagnetic field model for 50–30 ka BP. GFZ Data Services (dataset). CC BY 4.0, the code Apache 2.0. The model file was evaluated by our own script, which fetches it by URL; the zip's Fortran was not run.

7 Xu, C., Wei, S., Lu, Y., Zhang, Y., Chen, C., and Song, T. (2013). Removal of the local geomagnetic field affects reproductive growth in *Arabidopsis*. *Bioelectromagnetics* 34(6), 437–442. Abstract only, through Europe PMC; paraphrased. The abstract gives no value for the near-null field, and two reviews differ on it [8][9].

8 Binhi, V. N., and Prato, F. S. (2017). Biological effects of the hypomagnetic field: An analytical review of experiments and theories. *PLOS ONE* 12(6), e0179340. CC BY 4.0. Full text.

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11 Dhiman, S. K., and Galland, P. (2018). Effects of weak static magnetic fields on the gene expression of seedlings of *Arabidopsis thaliana*. *Journal of Plant Physiology* 231, 9–18. Abstract only, through Europe PMC; paraphrased.

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13 Parmagnani, A. S., Mannino, G., and Maffei, M. E. (2022). Transcriptomics and Metabolomics of Reactive Oxygen Species Modulation in Near-Null Magnetic Field-Induced *Arabidopsis thaliana*. *Biomolecules* 12(12), 1824. CC BY 4.0. Full text.

14 Parmagnani, A. S., Betterle, N., Mannino, G., D'Alessandro, S., Nocito, F. F., Ljumovic, K., Vigani, G., Ballottari, M., and Maffei, M. E. (2023). The Geomagnetic Field (GMF) Is Required for Lima Bean Photosynthesis and Reactive Oxygen Species Production. *International Journal of Molecular Sciences* 24(3), 2896. CC BY 4.0. Full text.

15 Mannino, G., Caldo, F., and Maffei, M. E. (2026). Reduced geomagnetic field modulates photosynthetic electron flow, menthol yield, flavonoid photoprotection and ROS homeostasis in peppermint (*Mentha × piperita* L.). *Plant Physiology and Biochemistry* 233, 111213. Abstract only, through Europe PMC; paraphrased.

16 Mannino, G., Caldo, F., and Maffei, M. E. (2026). Near-null magnetic fields remodel flavonoid profiles and essential oil content in *Ocimum basilicum* and are associated with altered photochemical performance and ROS homeostasis. *Journal of Plant Physiology* 326, 154872. Abstract only, through OpenAlex; paraphrased.

17 Mannino, G., Parmagnani, A. S., and Maffei, M. E. (2025). Reduction of the geomagnetic field to hypomagnetic field modulates tomato (*Solanum lycopersicum* L. cv Microtom) gene expression and metabolomics during plant development. *Journal of Plant Physiology* 306, 154453. Abstract only, through Europe PMC; paraphrased.

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21 Gu, Y., Wu, W., Su, X., Fang, Y., Shen, Y., Huang, J., and Xu, X. (2026). Hypomagnetic field inhibits seed germination via ROS signaling and reprogramming transcriptome in *Arabidopsis thaliana*. bioRxiv, a preprint, not peer reviewed. Abstract only, through Europe PMC; paraphrased.

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25 Bertea, C. M., Narayana, R., Agliassa, C., Rodgers, C. T., and Maffei, M. E. (2015). Geomagnetic Field (GMF) and Plant Evolution: Investigating the Effects of GMF Reversal on *Arabidopsis thaliana* Development and Gene Expression. *Journal of Visualized Experiments* 105, e53286. Full text, through Europe PMC.

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METHOD

How this was checked

On November 4, 2026, we checked every statement on this page about the paper against its full text and its supplement (Fig. S1, Tables S1–S4 and the workbook Data Set S1), which the site's owner downloaded from ScienceDirect, because that site refused our tools; the workbook was read as data, unzipped and parsed, with nothing in it run. The page also rests on 14 other papers whose full text we had, read for the passages we cite, one of them an accepted manuscript and one an unedited "Article in Press" PDF; 20 read only as abstracts, as the source list marks; five cited as read for our other pages; two cited from their records only; and the LSMOD.2 field model. With the S0 News episode that linked the paper, cited only for its date [2], these are the 44 sources listed. Every quotation was checked word for word against its saved source, and the sister pages' quotations against those pages; publishers' hyphen characters are printed as ordinary hyphens.

The verdicts and the items tagged "Our analysis" are our own assessment, built on the cited sources. They cover our readings of the paper's figures, the tests and corrections in section 5, the n recovered from Tables S2 and S3, the arithmetic between Data Set S1's columns, the coil estimate, the LSMOD.2 run and everything we conclude from them. Our tally of 99 flagged comparisons out of 178 is our own count, by eye for figure panels.

We recomputed Table 1 and Table S4 from their printed means and SDs, corrected Tables 1, S2, S3 and S4 and Data Set S1 for multiple tests, and evaluated LSMOD.2 on our own grid, at three samplings; the scripts, the rules and the outputs are hosted on the page, the rules for the supplement with their hashes. The rules on the arithmetic between columns were written after we had noticed it, and the rules files say so. Our run reproduces LSMOD.2's lowest dipole moment but not Korte's 0.12 µT to its digits, so we relaxed our own rule: we cite Korte for the point minimum, treat our point values as indicative, and keep the areas, which don't rest on it. We could not reproduce the percentages printed for Fig. 3F. We could not check the paper's raw chromatograms, the other per-sample data, or the field in Xu and colleagues' coil. We have not put the Data Set S1 finding to the authors. A fresh reviewer then checked the finished page. That review corrected our comparison with the lab's 10-second paper, which had left out what goes the other way, and our tally by one; replaced our count of plant rows in a review, our coil figures and our wording on what the field model shows; and added the authors' own statements on conditions and on "plant performance", fair context on the oil, and the nearest seedling test at 1–15 µT; and it made the section on Data Set S1 say that the arithmetic says nothing about anyone's intent, name the routine causes it sets aside and the innocent explanations it leaves open, and stop reading the tests on those columns against chance. No verdict changed. We re-derived every number it changed in our own scripts, under a rules addendum that says it follows the review.

On November 6, 2026, we revised the page to review the paper on its own. No transcript of the S0 News episode that linked it was available, and without one the site no longer comments on how an episode presented a paper. So the verdicts on the episode's title and its link's label were removed, with the page's other comments on the episode and on S0 News's earlier claims, and section 7 now weighs what the experiment can and can't show about plants in a geomagnetic reversal or excursion, from evidence the page already gave. The title, the panel's heading, the summary and the card no longer answer the episode's title. The revision drew on no new source, and the verdicts on the paper's four claims are unchanged.

This page was researched and written with Claude, an AI assistant made by Anthropic, and then re-checked against its sources in a separate verification pass.

The verdicts on this page

OVERSTATED	Has some basis but claims much more than the evidence supports.
UNCONFIRMED	Rests on a preliminary result that hasn't been confirmed.
PARTLY TRUE	Part of the claim holds up and part doesn't.
TRUE	The evidence supports the claim.

All ten verdicts, and how we check

CORRECTIONS

Corrections and changes

If we get something wrong, we fix it and record the change below with the date. If a correction changes a verdict, the log says what the old verdict was.

Change log

Nov 6, 2026	Revised to review the paper on its own. No transcript of the S0 News episode that linked it was available, and without one the site no longer comments on how an episode presented a paper. The verdicts on the episode's title and the link's label are removed, with the rest of the page's comment on the episode and on S0 News's earlier claims; section 1 now says only that S0 News linked the paper; the section on the episode is replaced by one on what the experiment can and can't show about plants in a geomagnetic reversal or excursion; and the verdicts on the paper's claims are unchanged. The title, the panel's heading, the summary and the card no longer answer the episode's title.
Nov 5, 2026	Published on factchecked.science after a full check against the sources. Built from the paper and its supplement, which the site's owner supplied, with the episode's title and link label (no transcript was available), the lab's other work, the literature on near-zero fields in plants, and our own re-runs of the paper's tables and of the LSMOD.2 field model, whose scripts are hosted on the page: six claims rated on the site's scale, two of them the episode's and four the paper's. No figure of the paper is redrawn, and neither its workbook nor LSMOD.2 is hosted. A fresh reviewer then checked the finished page; that review corrected our comparison with the lab's 10-second paper, our tally and a count in a review, and tightened our wording on what the field model shows and on what stays untested, and it made the section on Data Set S1 fairer to the authors. No verdict changed.

Fact-Checked Science is independent. It isn't affiliated with the channels, presenters or authors whose claims it checks.

Last updated Nov 6, 2026