

Supplementary Table S1. Primary root length and root fresh weight of soybean during the harvesting period in 2020.

Replicate	primary root length (mm)	fresh weight (g)
1	159.5	5.9
2	150.5	8.5
3	137	7
4	61	4.9
5	144.5	8.7
average	130.5	7
SD	35.52	1.47

SD, standard deviation.

Supplementary Table S2. Date of three growth stages (before sowing seeds, flowering, and harvesting) of the agricultural fields in 2019–2021.

year	2019		2020		2021	
growth stage	DAS	date	DAS	date	DAS	date
before sowing seeds	0	19-Jun	0	29-Jun	0	1-Jun
flowering	48	7-Aug	42	10-Aug	55	26-Jul
harvesting	126	23-Oct	120	27-Oct	147	26-Oct

DAS, day after sowing.

Supplementary Table S3. Annotated VOCs in soil profiles from agricultural fields collected in 2019.

Compound	RI	Class	Molecular Formula
1-Hexanol	872.2	Alcohol	C ₆ H ₁₄ O
1-Nonanol	1171.5	Alcohol	C ₉ H ₂₀ O
1-Octen-3-ol	981.7	Alcohol	C ₈ H ₁₆ O
2,4,7,9-Tetramethyl-5-decyn-4,7-diol	1406	Alcohol	C ₁₄ H ₂₆ O ₂
2-Ethyl-1-hexanol	1029.8	Alcohol	C ₈ H ₁₈ O
Pentyl alcohol	770.6	Alcohol	C ₅ H ₁₂ O
(Z)-2-Heptenal	959.7	Aldehyde	C ₇ H ₁₂ O
Benzaldehyde	964	Aldehyde	C ₇ H ₆ O
Hexanal	800.6	Aldehyde	C ₆ H ₁₂ O
Nonanal	1104.8	Aldehyde	C ₉ H ₁₈ O
Octanal	1003.4	Aldehyde	C ₈ H ₁₆ O
2,2,4,6,6-Pentamethyl heptane	989.9	Alkane	C ₁₂ H ₂₆
Tetradecane	1398.8	Alkane	C ₁₄ H ₃₀
Undecane	1099.6	Alkane	C ₁₁ H ₂₄
1,3-Dichloro benzene	1015.5	Aromatic	C ₆ H ₄ Cl ₂
2,4-Di-tert-butylphenol	1505.6	Aromatic	C ₁₄ H ₂₂ O
Butylated hydroxytoluene	1505	Aromatic	C ₁₅ H ₂₄ O
<i>m</i> -Dimethoxy benzene	1168.4	Aromatic	C ₁₅ H ₂₄ O
Naphthalene	1189.7	Aromatic	C ₁₀ H ₈
Styrene	891.4	Aromatic	C ₈ H ₈
(1R,5S,6R)-2,7,7-Trimethyl bicyclo [3.1.1] hept-2-en-6-yl acetate	1260.2	Ester	C ₁₂ H ₁₈ O ₂
Butanoic acid, 3-hydroxy-, methyl ester	864.1	Ester	C ₅ H ₁₀ O ₃
Nonanoic acid methyl ester	1222.5	Ester	C ₁₀ H ₂₀ O ₂
Pentanoic acid, 2,2,4-trimethyl-3-carboxyisopropyl, isobutyl ester	1588.3	Ester	C ₁₆ H ₃₀ O ₄
Nonanoic acid	1261.7	Fatty acid	C ₉ H ₁₈ O ₂
1-Pentyl furan	990.6	Heterocyclic	C ₉ H ₁₄ O
1-Octen-3-one	978.8	Ketone	C ₈ H ₁₄ O
4-Methyl-2-heptanone	939.3	Ketone	C ₈ H ₁₆ O
(-)-Borneol	1176.3	Terpene	C ₁₀ H ₁₈ O

3-Carene	1009.4	Terpene	C ₁₀ H ₁₆
α -Terpineol	1197.6	Terpene	C ₁₀ H ₁₈ O
Agarospinol	1642.9	Terpene	C ₁₅ H ₂₆ O
Camphor	1152.2	Terpene	C ₁₀ H ₁₆ O
Epicubenol	1637.9	Terpene	C ₁₅ H ₂₆ O
<i>p</i> -Cymene	1026.2	Terpene	C ₁₀ H ₁₄
Terpinen-4-ol	1183.9	Terpene	C ₁₀ H ₁₈ O

RI, retention index.

Supplementary Table S4. Annotated VOCs in soil profiles from agricultural fields collected in 2020.

Compound	RI	Class	Molecular formula
Toluene	744.7	Aromatic	C ₇ H ₈
1,3-Dimethyl benzene	861.4	Aromatic	C ₈ H ₁₀
1-Hexanol	864.7	Alcohol	C ₆ H ₁₄ O
3-Heptanone	887.2	Ketone	C ₇ H ₁₄ O
Styrene	890.7	Aromatic	C ₈ H ₈
1-Bromo-3-fluoro benzene	927.4	Aromatic	C ₆ H ₄ BrF
2-Ethyl hexanal	956.3	Aldehyde	C ₈ H ₁₆ O
(Z)-2-Heptenal	960.4	Aldehyde	C ₇ H ₁₂ O
1-Ethyl-4-methyl benzene	962.5	Aromatic	C ₉ H ₁₂
Benzaldehyde	964.8	Aldehyde	C ₇ H ₆ O
1,2,4-Trimethyl Benzene	994.3	Aromatic	C ₉ H ₁₂
Decane	1000.5	Alkane	C ₁₀ H ₂₂
Octanal	1003.9	Aldehyde	C ₈ H ₁₆ O
1,3-DichloroBenzene	1016.2	Aromatic	C ₆ H ₄ Cl ₂
<i>o</i> -Cymene	1026.6	Terpene	C ₁₀ H ₁₄
2-Ethyl-1-hexanol	1030	Alcohol	C ₈ H ₁₈ O
Benzyl alcohol	1042.5	Alcohol	C ₇ H ₈ O
Undecane	1099.9	Alkane	C ₁₁ H ₂₄
Nonanal	1105	Aldehyde	C ₉ H ₁₈ O
2-Ethyl hexanoic acid	1114.5	Fatty acid	C ₈ H ₁₆ O ₂
(-)-Camphor	1152.6	Ketone	C ₁₀ H ₁₆ O
2,3-Dimethyldecane	1154.5	Alkane	C ₁₂ H ₂₆
<i>m</i> -Dimethoxy benzene	1168.9	Aromatic	C ₁₅ H ₂₄ O
Naphthalene	1190.6	Aromatic	C ₁₀ H ₈
Dodecane	1199.9	Alkane	C ₁₂ H ₂₆
Undecanal	1307.6	Aldehyde	C ₁₁ H ₂₂ O
Decane, 2,3,5,8-tetramethyl-	1321.1	Alkane	C ₁₄ H ₃₀
γ -Amorphene	1394.7	Terpene	C ₁₅ H ₂₄
Tetradecane	1398.9	Alkane	C ₁₄ H ₃₀
2,4,7,9-Tetramethyl-5-decyn-4,7-diol	1406.5	Alcohol	C ₁₄ H ₂₆ O ₂
Epicubenol	1413.8	Terpene	C ₁₅ H ₂₆ O
α -Cedrene	1421.3	Terpene	C ₁₅ H ₂₄

Cyperene	1427.4	Terpene	C ₁₅ H ₂₄
9-epi-(<i>E</i>)-Caryophyllene	1471.6	Terpene	C ₁₅ H ₂₄
1-Dodecanol	1474.6	Alcohol	C ₁₅ H ₂₄
Nerolidol	1481.7	Terpene	C ₁₂ H ₂₆ O
2,4-Di- <i>tert</i> -butylphenol	1505.5	Alcohol	C ₁₄ H ₂₂ O
β-Elemene	1561.4	Terpene	C ₁₅ H ₂₄
Tridec-(<i>2E</i>)-en-1-ol	1575.4	Alcohol	C ₁₃ H ₂₆ O
Propanoic acid, 2-methyl-, 2,2-dimethyl-1-(1-methylethyl)-1,3-propanediyl ester	1587.8	Ester	C ₁₆ H ₃₀ O ₄
Pentanoic acid, 2,2,4-trimethyl-3-carboxyisopropyl, isobutyl ester	1589.2	Ester	C ₁₆ H ₃₀ O ₄
Longifolene	1637.2	Terpene	C ₁₅ H ₂₄
Heptadecane	1698.1	Alkane	C ₁₇ H ₃₆
(<i>Z</i>)-11-Hexadecenoic acid, methyl ester	1913.7	Ester	C ₁₇ H ₃₂ O ₂
Hexadecanoic acid, methyl ester	1927.8	Ester	C ₁₇ H ₃₄ O ₂

RI, retention index.

Supplementary Table S5. Annotated VOCs in soil profiles from agricultural fields collected in 2021.

Compound	RI	Class	Molecular Formula
Hexanal	803.9	Aldehyde	C ₆ H ₁₂ O
Methyl (S)-(+)-3-Hydroxybutyrate	862.1	Ester	C ₅ H ₁₀ O ₃
<i>p</i> -Xylene	869.6	Aromatic	C ₈ H ₁₀
1-Hexanol	871.1	Alcohol	C ₆ H ₁₄ O
3-Heptanone	886.1	Ketone	C ₇ H ₁₄ O
Styrene	889.9	Aromatic	C ₈ H ₈
α -Pinene	934.6	Terpene	C ₁₀ H ₁₆
2-Ethyl Hexanal	955.1	Aldehyde	C ₈ H ₁₆ O
(<i>Z</i>)-2-Heptenal	958	Aldehyde	C ₇ H ₁₂ O
2-Ethyl-2-Hexenal	967.3	Aldehyde	C ₈ H ₁₄ O
1-Heptanol	971.5	Alcohol	C ₇ H ₁₆ O
Benzaldehyde	976.1	Aldehyde	C ₇ H ₆ O
3-Butenyl-Isothiocyanate	979.3	Ester	C ₅ H ₇ NS
1-Octen-3-ol	980.6	Alcohol	C ₈ H ₁₆ O
3-Octanol	996.8	Alcohol	C ₈ H ₁₈ O
Decane	1000.1	Alkane	C ₁₀ H ₂₂
Octanal	1002.3	Aldehyde	C ₈ H ₁₆ O
<i>p</i> -Cymene	1025.8	Terpene	C ₁₀ H ₁₄
2-Ethyl-1-Hexanol	1028.7	Alcohol	C ₈ H ₁₈ O
Benzeneacetaldehyde	1045.1	Aldehyde	C ₈ H ₈ O
2 <i>E</i> -Octenal	1058.5	Aldehyde	C ₈ H ₁₄ O
Nonanal	1103.5	Aldehyde	C ₉ H ₁₈ O
3,4,5,6-Tetramethyl Octane	1106.3	Alkane	C ₁₂ H ₂₆
(-)-Camphor	1151.3	Terpene	C ₁₀ H ₁₆ O
<i>m</i> -Dimethoxy benzene	1167.1	Aromatic	C ₁₅ H ₂₄ O
1-Nonanol	1170.6	Alcohol	C ₉ H ₂₀ O
(-)-Borneol	1176.2	Terpene	C ₁₀ H ₁₈ O
Naphthalene	1189.4	Aromatic	C ₁₀ H ₈
α -Terpineol	1197.1	Terpene	C ₁₀ H ₁₈ O
2,10-Dimethyl Undecane	1224.7	Alkane	C ₁₂ H ₂₈
5-Ethyl Undecane	1243.8	Alkane	C ₁₃ H ₂₈
Nonanoic acid	1259.9	Fatty acid	C ₉ H ₁₈ O ₂
3-Methyl Dodecane	1269.5	Alkane	C ₁₃ H ₂₈

2-Butyl-1-Octanol	1270.8	Alcohol	C ₁₂ H ₂₆ O
2,6,11-Trimethyl Dodecane	1274.9	Alkane	C ₁₅ H ₃₂
2-Butyl-1-Octanol	1277.8	Alcohol	C ₁₂ H ₂₆ O
4,6-Dimethyl Dodecane	1321	Alkane	C ₁₄ H ₃₀
2,2,4,4,6,8,8-Heptamethyl Nonane	1323.4	Alkane	C ₁₆ H ₃₄
2,6,10-Trimethyl Dodecane	1369.8	Alkane	C ₁₅ H ₃₂
Propanoic acid, 2-methyl-, 2-ethyl- 3-hydroxyhexyl ester	1373.5	Ester	C ₁₂ H ₂₄ O ₃
3-Methyl Tridecane	1385.3	Alkane	C ₁₄ H ₃₀
4-(1,1-dimethylpropyl)-Phenol	1393.6	Aromatic	C ₁₁ H ₁₆ O
Tetradecane	1399	Alkane	C ₁₄ H ₃₀
2,4,7,9-Tetramethyl-5-decyn-4,7- diol	1405.4	Alcohol	C ₁₄ H ₂₆ O ₂
Aromadendrene	1448.5	Terpene	C ₁₅ H ₁₂ O ₆
Germacrene D	1482	Terpene	C ₁₅ H ₂₄
Pentadecane	1487.8	Alkane	C ₁₅ H ₃₂
2,2-Dimethyl Tetradecane	1515.2	Alkane	C ₁₆ H ₃₄
γ-Cadinene	1521	Terpene	C ₁₅ H ₂₄
(+)-δ-Cadinene	1525	Terpene	C ₁₅ H ₂₄
Pentanoic acid, 2,2,4-trimethyl-3- carboxyisopropyl, isobutyl ester	1587.2	Ester	C ₁₆ H ₃₀ O ₄
4-(1,1,3,3-tetramethylbutyl)-Phenol	1602.2	Aromatic	C ₁₄ H ₂₂ O
Hexadecane	1607.5	Alkane	C ₁₆ H ₃₄
α-Cadinol	1664.4	Terpene	C ₁₅ H ₂₆ O
Tetradecanol	1676.7	Alcohol	C ₁₄ H ₃₀ O
Heptadecane	1699.2	Alkane	C ₁₇ H ₃₆
3,5-di- <i>tert</i> -Butyl-4- hydroxybenzaldehyde	1758.9	Aldehyde	C ₁₅ H ₂₂ O ₂
Hexadecane, 2,6,10,14-tetramethyl- 7,9-Di- <i>tert</i> -butyl-1-	1799.8	Alkane	C ₂₀ H ₄₂
oxaspiro(4,5)deca-6,9-diene-2,8- dione	1906.1	Ketone	C ₁₇ H ₂₄ O ₃
2,2-Dimethyloctadecane	1919.1	Alkane	C ₂₀ H ₄₂
Hexadecanoic acid, methyl ester	1926.4	Ester	C ₁₇ H ₃₄ O ₂
Dibutyl phthalate	1964.4	Ester	C ₁₆ H ₂₂ O ₄

RI, retention index.