

Figure S1. Weather parameters: rainfall (mm), minimum temperature (T_{\min} , °C), maximum temperature (T_{\max} , °C), minimum relative humidity (RH_{\min} , %), and maximum relative humidity (RH_{\max} , %) during the period of cultivation of hemp plants in 2020 and 2021.

Table S1. Dataset for the traits analyzed in the hemp plants obtained from uninoculated seeds and seeds inoculated with T-AA and T-22 strains at stages S6 and S10 in 2020.

Trait ^a	S6			S10		
	Ctr	T-AA	T-22	Ctr	T-AA	T-22
Shoot length (cm)	33.733±1.263 ^b	29.867±1.233	37.067±0.719	42.617±2.180	47.917±1.823	58.983±1.018
Total root length (cm)	614.498±21.116	488.593±34.645	643.893±48.398	1403.947±55.932	1340.242±130.226	1646.297±70.254
Shoot dry weight (g)	0.193±0.008	0.152±0.010	0.200±0.010	0.437±0.013	0.486±0.024	0.588±0.013
Root dry weight (g)	0.020±0.001	0.020±0.001	0.023±0.001	0.059±0.002	0.062±0.008	0.077±0.006
Shoot/root dry weight	9.570±0.507	7.603±0.654	8.985±0.408	7.418±0.324	8.297±0.835	7.807±0.463
Total root surface area (cm ²)	47.205±1.681	37.697±2.151	48.105±1.488	124.440±3.448	112.123±4.039	153.848±11.451
Root average diameter (mm)	0.242±0.007	0.257±0.008	0.237±0.004	0.272±0.016	0.258±0.012	0.293±0.016
Total root volume (cm ³)	0.298±0.017	0.248±0.021	0.288±0.015	0.892±0.102	0.752±0.055	1.160±0.114
Root tips (n)	2317.283±138.765	2343.000±37.668	2621.600±101.909	3579.333±139.652	3865.667±106.011	4874.017±195.656
Root forks (n)	2259.900±125.809	2341.500±129.413	2864.017±128.962	7772.000±930.135	7030.667±650.673	10301.233±604.313
Root crossings (n)	1155.517±79.879	815.950±55.082	1237.800±101.204	3520.833±137.877	3271.833±173.373	4737.900±196.005
TRL (0.0-0.5 mm)	585.233±22.813	471.750±33.538	616.100±45.385	1325.267±58.012	1263.583±126.596	1485.250±62.362
TRL (0.5-1.0 mm)	26.615±2.000	15.267±1.904	24.582±3.580	61.818±4.765	63.102±7.904	131.623±5.352
TRL (>1.0 mm)	2.667±0.371	1.598±0.222	3.223±0.692	16.858±5.091	13.562±3.942	29.415±7.893
TRSA (0.0-0.5 mm)	41.015±1.817	34.075±1.841	41.708±1.224	99.728±5.523	90.415±1.683	113.707±10.315
TRSA (0.5-1.0 mm)	5.113±0.363	2.865±0.386	4.967±0.337	17.698±3.167	15.498±2.182	26.437±2.288
TRSA (>1.0 mm)	1.073±0.158	0.757±0.104	1.430±0.187	7.017±1.859	6.212±1.063	13.708±0.725
TRV (0.0-0.5 mm)	0.177±0.017	0.177±0.017	0.160±0.011	0.312±0.062	0.298±0.083	0.238±0.055
TRV (0.5-1.0 mm)	0.082±0.005	0.043±0.007	0.078±0.007	0.308±0.059	0.240±0.036	0.442±0.061
TRV (>1.0 mm)	0.037±0.005	0.028±0.006	0.050±0.006	0.275±0.078	0.215±0.065	0.488±0.108
RT (0.0-0.5 mm)	2312.190±137.710	2336.445±38.485	2615.087±102.096	3563.443±139.841	3850.387±106.056	4853.745±195.399
RT (0.5-1.0 mm)	5.078±1.432	6.535±1.860	6.485±0.967	15.155±2.118	14.947±0.857	18.987±3.564
RT (>1.0 mm)	0.038±0.038	0.022±0.022	0.028±0.020	0.735±0.353	0.333±0.333	1.292±0.678
TPC (mg/g)	12.507±0.427	15.013±0.422	15.907±0.309	9.367±0.566	10.346±0.369	13.078±0.386
TFC (mg/g)	1.098±0.062	1.470±0.118	1.543±0.134	0.391±0.065	0.493±0.019	0.791±0.048
DPPH (μmol/g)	59.027±1.834	66.927±1.286	71.412±0.494	63.734±3.307	65.752±1.593	78.347±1.221
ABTS (mmol/g)	27.897±0.303	34.942±0.487	35.915±0.493	28.962±1.705	36.225±1.398	36.672±1.512

^aTRL, total root length; TRSA, total root surface area; TRV, total root volume; RT, root tips; TPC, total phenolic content; TFC, total flavonoid content; DPPH, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity; ABTS, 2,2-azinobis-(3-ethylbenzothiazoline-6-sulphonic acid) radical scavenging activity.

^bValues are expressed as mean ± SE.

Table S2. Dataset for the traits analyzed in the hemp plants obtained from uninoculated seeds and seeds inoculated with T-AA and T-22 strains at stages S6 and S10 in 2021.

Trait ^a	S6			S10		
	Ctr	T-AA	T-22	Ctr	T-AA	T-22
Shoot length (cm)	23.904±0.516 ^b	29.600±2.745	33.467±2.207	44.700±3.347	44.550±2.864	51.700±2.020
Total root length (cm)	126.261±11.414	140.083±15.002	195.513±14.865	176.150±22.607	278.032±30.529	389.944±37.873
Shoot dry weight (g)	0.110±0.006	0.133±0.011	0.143±0.007	0.288±0.014	0.327±0.019	0.349±0.024
Root dry weight (g)	0.007±0.001	0.009±0.001	0.010±0.001	0.018±0.001	0.017±0.002	0.025±0.006
Shoot/root dry weight	16.874±1.804	16.538±2.311	15.115±1.675	16.556±1.218	20.454±2.774	19.632±5.093
Total root surface area (cm ²)	8.979±0.537	10.549±0.129	14.183±0.871	13.294±2.552	17.620±2.456	27.737±4.169
Root average diameter (mm)	0.231±0.010	0.235±0.010	0.240±0.012	0.255±0.020	0.218±0.005	0.215±0.005
Total root volume (cm ³)	0.058±0.007	0.075±0.008	0.085±0.008	0.130±0.017	0.113±0.016	0.212±0.069
Root tips (n)	491.167±86.293	492.833±85.547	789.500±89.509	744.188±100.521	949.167±109.791	1522.167±204.996
Root forks (n)	320.500±20.098	403.667±37.581	522.750±27.169	540.188±82.632	676.833±113.083	1206.646±168.376
Root crossings (n)	116.167±9.181	151.500±1.648	187.583±5.481	193.313±50.479	248.167±68.839	554.271±88.722
TRL (0.0-0.5 mm)	120.466±11.924	134.486±14.802	188.601±14.893	168.389±22.322	270.772±30.022	380.752±37.263
TRL (0.5-1.0 mm)	3.897±0.565	3.790±0.454	4.403±0.790	4.410±0.635	4.381±0.388	6.557±0.788
TRL (>1.0 mm)	1.898±0.294	1.807±0.205	2.509±0.239	3.351±0.280	2.879±0.329	2.636±0.472
TRSA (0.0-0.5 mm)	7.536±0.628	8.988±0.185	12.387±0.956	10.667±2.444	15.523±2.267	24.317±3.273
TRSA (0.5-1.0 mm)	0.774±0.108	0.739±0.088	0.858±0.152	0.977±0.171	0.758±0.123	1.826±0.709
TRSA (>1.0 mm)	0.669±0.104	0.822±0.105	0.938±0.204	1.650±0.297	1.339±0.198	1.594±0.428
TRV (0.0-0.5 mm)	0.025±0.004	0.032±0.006	0.037±0.007	0.045±0.012	0.045±0.009	0.087±0.025
TRV (0.5-1.0 mm)	0.020±0.003	0.032±0.005	0.033±0.008	0.070±0.011	0.057±0.010	0.095±0.035
TRV (>1.0 mm)	0.013±0.002	0.012±0.002	0.015±0.002	0.015±0.002	0.012±0.002	0.030±0.010
RT (0.0-0.5 mm)	488.500±85.873	490.833±85.190	788.167±89.317	742.021±99.924	948.000±109.739	1519.500±204.337
RT (0.5-1.0 mm)	2.000±0.632	1.500±0.563	1.167±0.477	1.833±1.138	0.667±0.333	2.333±0.843
RT (>1.0 mm)	0.667±0.333	0.500±0.224	0.167±0.167	0.333±0.333	0.500±0.342	0.333±0.211
TPC (mg/g)	6.095±0.289	7.144±0.389	8.241±0.260	7.899±0.228	8.718±0.349	9.489±0.403
TFC (mg/g)	0.565±0.029	0.681±0.030	0.899±0.066	0.727±0.045	0.891±0.061	1.005±0.044
DPPH (μmol/g)	49.208±0.779	55.121±0.654	59.500±0.838	68.378±1.052	81.309±2.213	80.907±1.510
ABTS (mmol/g)	15.935±0.457	17.847±0.512	19.919±0.444	18.039±2.811	20.429±2.384	23.881±3.359

^aTRL, total root length; TRSA, total root surface area; TRV, total root volume; RT, root tips; TPC, total phenolic content; TFC, total flavonoid content; DPPH, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity; ABTS, 2,2-azinobis-(3-ethylbenzothiazoline-6-sulphonic acid) radical scavenging activity.

^bValues are expressed as mean ± SE.

Table S3. Analysis of variance for the traits analyzed in the hemp plants obtained from uninoculated seeds and seeds inoculated with T-AA and T-22 strains at stages S6 and S10 in 2020 and 2021.

Trait^a	Year (Y) df (1)	Stage (S) df (1)	Treatment (T) df (2)	Y × S df (2)	Y × T df (2)	S × T df (2)	Y × S × T df (2)
Shoot length (cm)	**	***	***	n.s.	n.s.	n.s.	*
Total root length (cm)	***	***	***	***	n.s.	n.s.	n.s.
Shoot dry weight (g)	***	***	***	***	*	***	*
Root dry weight (g)	***	***	*	***	n.s.	n.s.	n.s.
Shoot/root dry weight	***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Total root surface area (cm ²)	***	***	***	***	**	**	n.s.
Root average diameter (mm)	***	n.s.	n.s.	*	n.s.	n.s.	n.s.
Total root volume (cm ³)	***	***	**	***	n.s.	**	n.s.
Root tips (n)	***	***	***	***	n.s.	***	n.s.
Root forks (n)	***	***	***	***	*	*	n.s.
Root crossings (n)	***	***	***	***	***	***	**
TRL (0.0-0.5 mm)	***	***	***	***	n.s.	n.s.	n.s.
TRL (0.5-1.0 mm)	***	***	***	***	***	***	***
TRL (>1.0 mm)	***	***	n.s.	***	n.s.	n.s.	n.s.
TRSA (0.0-0.5 mm)	***	***	***	***	n.s.	n.s.	n.s.
TRSA (0.5-1.0 mm)	***	***	*	***	*	*	n.s.
TRSA (>1.0 mm)	***	***	***	***	n.s.	**	***
TRV (0.0-0.5 mm)	***	**	n.s.	*	n.s.	n.s.	n.s.
TRV (0.5-1.0 mm)	***	***	**	***	n.s.	*	n.s.
TRV (>1.0 mm)	***	***	*	***	n.s.	n.s.	n.s.
RT (0.0-0.5 mm)	***	***	***	***	n.s.	***	n.s.
RT (0.5-1.0 mm)	***	***	n.s.	***	n.s.	n.s.	n.s.
RT (>1.0 mm)	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.
TPC (mg/g)	***	***	***	***	**	n.s.	n.s.
TFC (mg/g)	***	***	***	***	n.s.	n.s.	n.s.
DPPH (μmol/g)	n.s.	***	***	***	*	n.s.	**
ABTS (μmol/g)	***	*	***	n.s.	n.s.	n.s.	n.s.

^aTRL, total root length; TRSA, total root surface area; TRV, total root volume; RT, root tips; TPC, total phenolic content; TFC, total flavonoid content; DPPH, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity; ABTS, 2,2-azino-bis-(3-ethylbenzothiazoline-6-sulphonic acid) radical scavenging activity.

*** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; n.s., not significant.

Table S4. Mean values per year, stage, and stage for each year of the traits that were significant in the analysis of variance (see Table S3).

Trait ^a	Year (Y)		Stage (S)		Y × S			
	2020	2021	S6	S10	S6-2020	S10-2020	S6-2021	S10-2021
Shoot length (cm)	41.70 A	37.99 B	31.27 <i>b</i>	48.41 <i>a</i>	—	—	—	—
Total root length (cm) Shoot	1022.91 A	217.66 B	368.14 <i>b</i>	872.44 <i>a</i>	582.33 <i>b</i>	1463.50 <i>a</i>	153.95 <i>d</i>	281.38 <i>c</i>
dry weight (g)	0.34 A	0.23 B	0.16 <i>b</i>	0.41 <i>a</i>	0.18 <i>c</i>	0.50 <i>a</i>	0.13 <i>d</i>	0.32 <i>b</i>
Root dry weight (g)	0.04 A	0.01 B	0.01 <i>b</i>	0.04 <i>a</i>	0.02 <i>b</i>	0.07 <i>a</i>	0.01 <i>c</i>	0.02 <i>b</i>
Shoot/root dry weight Total	8.28 B	17.53 A	—	—	—	—	—	—
root surface area (cm ²) Root	87.24 A	15.39 B	27.79 <i>b</i>	74.84 <i>a</i>	44.34 <i>b</i>	130.14 <i>a</i>	11.24 <i>c</i>	19.55 <i>c</i>
average diameter (mm)	0.26 A	0.23 B	—	—	0.25 <i>b</i>	0.27 <i>a</i>	0.24 <i>b</i>	0.23 <i>b</i>
Total root volume (cm ³)	0.61 A	0.11 B	0.18 <i>b</i>	0.54 <i>a</i>	0.28 <i>b</i>	0.93 <i>a</i>	0.07 <i>c</i>	0.15 <i>c</i>
Root tips (n)	3266.82 A	831.50 B	1509.23 <i>b</i>	2589.09 <i>a</i>	2427.29 <i>b</i>	4106.34 <i>a</i>	591.17 <i>d</i>	1071.84 <i>c</i>
Root forks (n)	5428.22 A	611.76 B	1452.06 <i>b</i>	4587.93 <i>a</i>	2488.47 <i>b</i>	8367.97 <i>a</i>	415.64 <i>c</i>	807.89 <i>c</i>
Root crossings (n)	2456.64 A	241.83 B	610.75 <i>b</i>	2087.72 <i>a</i>	1069.76 <i>b</i>	3843.52 <i>a</i>	151.75 <i>c</i>	331.92 <i>c</i>
TRL (0.0-0.5 mm)	957.86 A	210.58 B	352.77 <i>b</i>	815.67 <i>a</i>	557.69 <i>b</i>	1358.03 <i>a</i>	147.85 <i>d</i>	273.30 <i>c</i>
TRL (0.5-1.0 mm)	53.83 A	4.57 B	13.09 <i>b</i>	45.32 <i>a</i>	22.15 <i>b</i>	85.51 <i>a</i>	4.03 <i>c</i>	5.12 <i>c</i>
TRL (>1.0 mm)	11.22 A	2.51 B	2.28 <i>b</i>	11.45 <i>a</i>	2.50 <i>b</i>	19.95 <i>a</i>	2.07 <i>b</i>	2.96 <i>b</i>
TRSA (0.0-0.5 mm)	70.11 A	13.24 B	24.28 <i>b</i>	59.06 <i>a</i>	38.93 <i>b</i>	101.28 <i>a</i>	9.64 <i>c</i>	16.84 <i>c</i>
TRSA (0.5-1.0 mm)	12.10 A	0.99 B	2.55 <i>b</i>	10.53 <i>a</i>	4.32 <i>b</i>	19.88 <i>a</i>	0.79 <i>c</i>	1.19 <i>c</i>
TRSA (>1.0 mm)	5.03 A	1.17 B	0.95 <i>b</i>	5.25 <i>a</i>	1.09 <i>b</i>	8.98 <i>a</i>	0.81 <i>b</i>	1.53 <i>b</i>
TRV (0.0-0.5 mm)	0.23 A	0.05 B	0.10 <i>b</i>	0.17 <i>a</i>	0.17 <i>b</i>	0.28 <i>a</i>	0.03 <i>c</i>	0.06 <i>c</i>
TRV (0.5-1.0 mm)	0.20 A	0.05 B	0.05 <i>b</i>	0.20 <i>a</i>	0.07 <i>b</i>	0.33 <i>a</i>	0.03 <i>b</i>	0.07 <i>b</i>
TRV (>1.0 mm) RT	0.18 A	0.02 B	0.03 <i>b</i>	0.17 <i>a</i>	0.04 <i>b</i>	0.33 <i>a</i>	0.01 <i>b</i>	0.02 <i>b</i>
(0.0-0.5 mm) RT	3255.22 A	829.50 B	1505.20 <i>b</i>	2579.52 <i>a</i>	2421.24 <i>b</i>	4089.19 <i>a</i>	589.17 <i>d</i>	1069.84 <i>c</i>
(0.5-1.0 mm) RT	11.20 A	1.58 B	3.79 <i>b</i>	8.99 <i>a</i>	6.03 <i>b</i>	16.36 <i>a</i>	1.56 <i>c</i>	1.61 <i>c</i>
(>1.0 mm) TPC	—	—	—	—	0.03 <i>b</i>	0.79 <i>a</i>	0.44 <i>ab</i>	0.39 <i>ab</i>
(mg/g)	12.70 A	7.93 B	10.82 <i>a</i>	9.82 <i>b</i>	14.48 <i>a</i>	10.93 <i>b</i>	7.16 <i>d</i>	8.70 <i>c</i>
TFC (mg/g) DPPH	0.96 A	0.79 B	1.04 <i>a</i>	0.72 <i>b</i>	1.37 <i>a</i>	0.56 <i>d</i>	0.71 <i>c</i>	0.87 <i>b</i>
(μmol/g) ABTS	—	—	60.20 <i>b</i>	73.07 <i>a</i>	65.79 <i>c</i>	69.28 <i>b</i>	54.61 <i>d</i>	76.86 <i>a</i>
(mmol/g)	33.44 A	19.34 B	25.41 <i>b</i>	27.37 <i>a</i>	—	—	—	—

^aTRL, total root length; TRSA, total root surface area; TRV, total root volume; RT, root tips; TPC, total phenolic content; TFC, total flavonoid content; DPPH, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity; ABTS, 2,2-azino-bis-(3-ethylbenzothiazoline-6-sulphonic acid) radical scavenging activity. Different capital, italic, and lower-case letters in the same row represent significant differences ($p \leq 0.05$) between the two years, the two stages and the four combinations between years/stages, respectively.

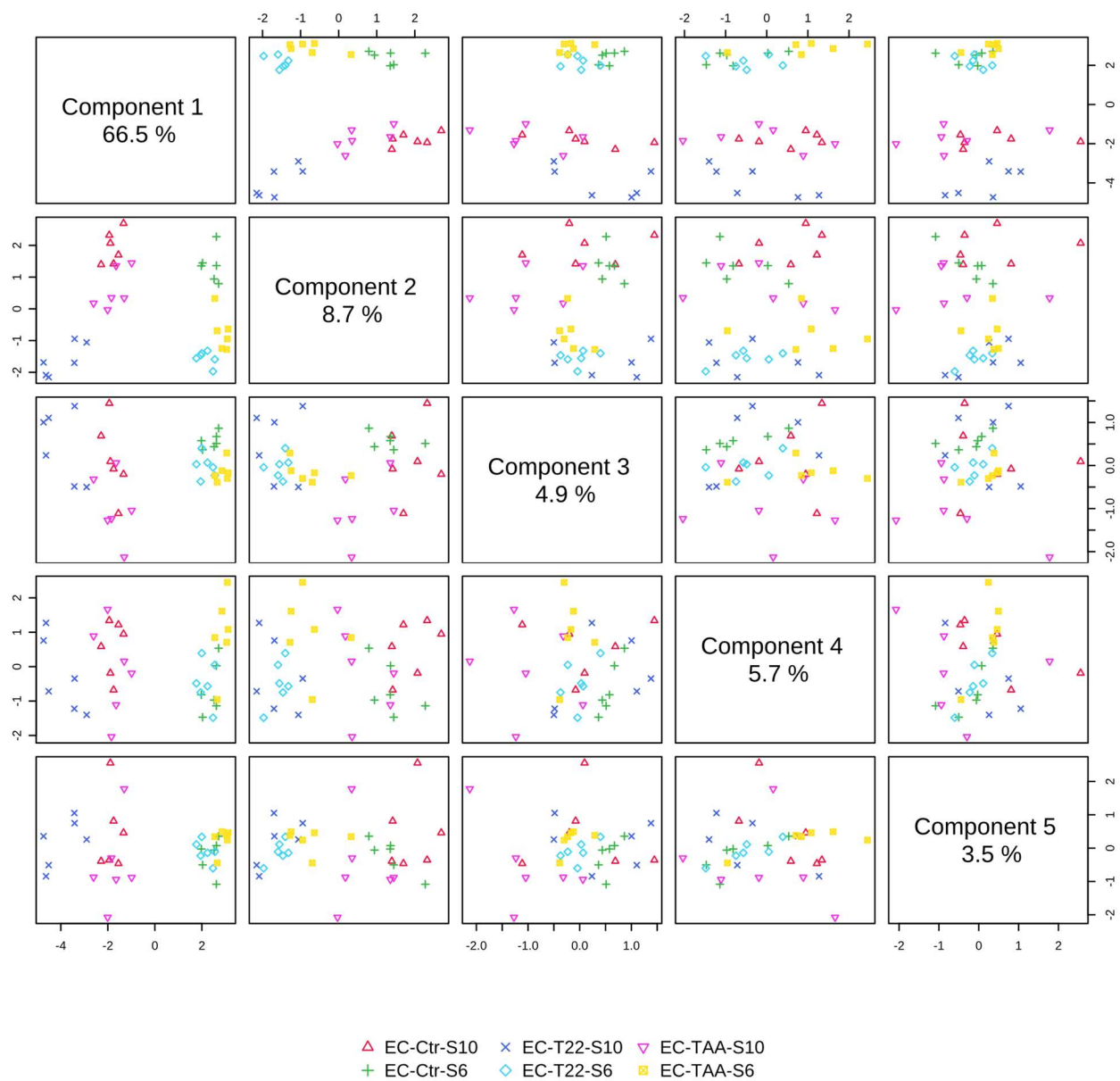


Figure S2. Sparse partial least squares discriminant analysis overview plot showing the five components in 2020.

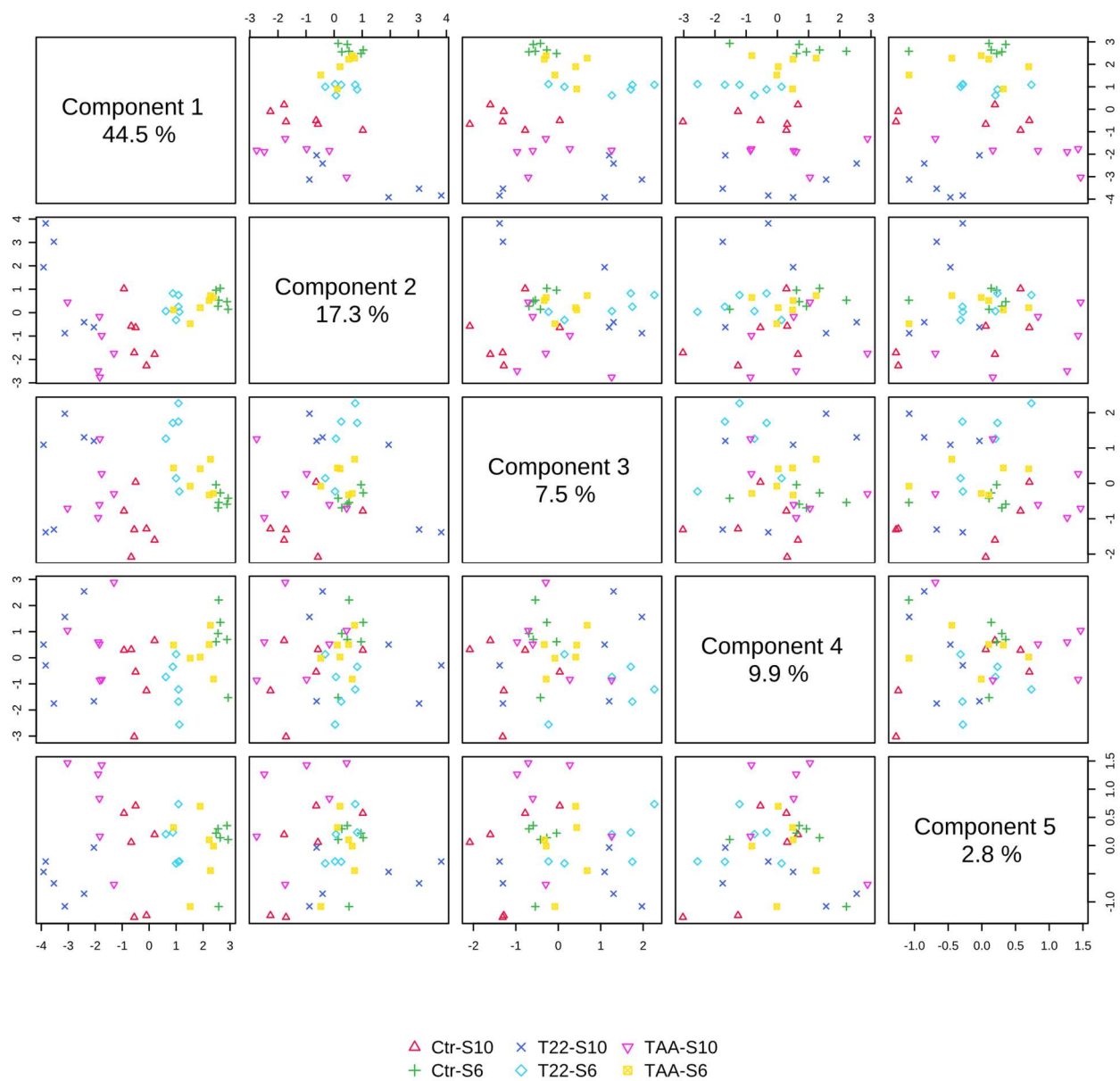


Figure S3. Sparse partial least squares discriminant analysis overview plot showing the five components in 2021.