Supplementary Material

Shoot/root interactions affect soybean photosynthetic traits and yield formation: a case study of grafting with record-yield cultivars

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## Supplementary Figures

**Fig. S1 Seed number and seed weight (per hundred seeds) of self-grafted the USA and Chinese cultivars. Wlm: Williams; Ams: Amsoy; L10: Liaodou10; T31: Tiefeng31; L11: Liaodou11; L3: Liaodou3; Rsk: Resnik; L12: Liaodou12; Ktm: Kottam; Dlw: Dilworth; Dnn: Dennison; L14: Liaodou14; Z35: Zhonghuang35.**

## Supplementary Tables

**Table S1 the USA and Chinese soybean cultivars for grafting**

**Table S2 *Pearson’s* correlation coefficients between photosynthetic and root architectural indexes during reproductive stages in 2014 and 2015**

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**Fig. S1 Seed number (A) and seed weight (per hundred seeds) (B) of self-grafted the USA and Chinese cultivars. Wlm: Williams; Ams: Amsoy; L10: Liaodou10; T31: Tiefeng31; L11: Liaodou11; L3: Liaodou3; Rsk: Resnik; L12: Liaodou12; Ktm: Kottam; Dlw: Dilworth; Dnn: Dennison; L14: Liaodou14; Z35: Zhonghuang35.**

**Table S1 the USA and Chinese soybean cultivars for grafting**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Group | Cultivar | Growth habit | Ancestor | Breeding Location | Year of release | Pedigree |
| Common parents (Dp) | Amsoy | Indeterminate | - | Iowa State, USA | 1966 | Adams × Harosoy |
| Williams | Indeterminate | - | USDA, USA | 1971 | Wayne × L57-0034 |
|  |  |  |  |  |  |  |
| Second-generation cultivars (Ds) | Liaodou 3 | Semi-determinate | Amsoy | Liaoning, CN | 1983 | Tiefeng18 × Amsoy |
| Liaodou 10 | Semi-determinate | Amsoy | Liaoning, CN | 1991 | Liaodou 3 × Liao 82-5185 |
| Resnik | Indeterminate | Williams | Ohio State, USA | 1987 | A3127 × L24 |
| Kottman | Indeterminate | Amsoy, Williams | Ohio State, USA | 1991 | HS88-7363× HS88-4988 |
|  |  |  |  |  |  |  |
| Current cultivars (Dc) | Liaodou 11 | Semi-determinate | Amsoy | Liaoning, CN | 1996 | Liao 84063 × Liaodou 3 |
| Liaodou 12 | Semi-determinate | Amsoy | Liaoning, CN | 2001 | Liao 85094 × Liaodou 10 |
| Tiefeng 31 | Semi-determinate | Williams | Tieling, CN | 2001 | Xin 3511 × Resnik |
| Dilworth | Indeterminate | Williams | Ohio, USA | 2002 | Chapman × Probst |
| Dennison | Indeterminate | Amsoy, Williams | Ohio, USA | 2006 | Athow × HS94-4533 |
|  |  |  |  |  |  |  |
| Record-yield | Liaodou14  (L14) | Semi-determinate | - | Liaoning, CN | 2003 | Liaodou10 × Mecury |
| Zhonghuang35  (Z35) | Determinate | - | Beijing, CN | 2006 | (PI486355 × Zheng 8431)  × Zheng 6062 |

**Table S2 *Pearson’s* correlation coefficients between photosynthetic and root architectural indexes during reproductive stages in 2014 and 2015**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Year of 2014 | | | | | |  | Year of 2015 | | | | | |
|  |  | R2 | | R5 | | R6 | |  | R2 | | R5 | | R6 | |
|  |  | Length | Dry mass | Length | Dry mass | Length | Dry mass |  | Length | Dry mass | Length | Dry mass | Length | Dry mass |
| D/D | *P*N | 0.02 NS | 0.16 NS | 0.14 NS | 0.21 NS | 0.66 \*\* | 0.42 \* |  | -0.01 NS | 0.23 NS | -0.02 NS | 0.12 NS | 0.01 NS | 0.29 NS |
| *g*s | -0.09 NS | -0.12 NS | -0.21 NS | 0.02 NS | 0.66 \*\* | 0.62 \*\* |  | 0.32 NS | 0.32 NS | 0.00 NS | -0.03 NS | 0.12 NS | 0.24 NS |
| *E* | 0.15 NS | 0.06 NS | 0.20 NS | 0.46 \*\* | 0.41\* | 0.28 NS |  | -0.02 NS | -0.13 NS | 0.37 \* | 0.36 \* | 0.20 NS | 0.00 NS |
| Leaf greeness | 0.15 NS | 0.19 NS | -0.19 NS | -0.06 NS | 0.22 NS | 0.20 NS |  | 0.26 NS | 0.18 NS | -0.23 NS | -0.14 NS | -0.15 NS | 0.23 NS |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| L/D | *P*N | 0.67 \*\* | 0.31 NS | -0.06 NS | -0.07 NS | 0.87 \*\* | 0.77\*\* |  | 0.38 \* | 0.53 \*\* | -0.01 NS | -0.04 NS | 0.73 \*\* | 0.79 \*\* |
| *g*s | 0.29 NS | 0.20 NS | -0.27 NS | -0.14 NS | 0.70 \*\* | 0.64 \*\* |  | -0.12 NS | 0.52 \*\* | -0.18 NS | -0.09 NS | 0.60 \*\* | 0.70 \*\* |
| *E* | 0.55 \*\* | 0.08 NS | 0.13 NS | 0.25 NS | 0.62 \*\* | 0.63 \*\* |  | -0.23 NS | 0.50 \*\* | 0.17 NS | 0.19 NS | 0.58 \*\* | 0.62 \*\* |
| Leaf greeness | 0.69 \*\* | 0.27 NS | 0.15 NS | 0.10 NS | 0.33 NS | 0.19 NS |  | 0.22 NS | 0.27 NS | 0.13 NS | 0.03 NS | 0.24 NS | 0.33 NS |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Z/D | *P*N | 0.43 \* | -0.19 NS | -0.19 NS | -0.28 NS | 0.85 \*\* | 0.78 \*\* |  | 0.14 NS | 0.42 \* | 0.52 \*\* | 0.55 \*\* | 0.82 \*\* | 0.90 \*\* |
| *g*s | 0.11 NS | -0.21 NS | -0.10 NS | 0.01 NS | 0.44 \* | 0.32 NS |  | 0.18 NS | 0.08 NS | -0.02 NS | 0.04 NS | 0.48 \*\* | 0.47 \*\* |
| *E* | 0.11 NS | -0.40 \* | 0.02 NS | 0.15 NS | 0.56 \*\* | 0.62 \*\* |  | 0.11 NS | 0.20 NS | 0.57 \*\* | 0.66 \*\* | 0.50 \*\* | 0.51 \*\* |
| Leaf greeness | -0.02 NS | 0.06 NS | -0.15 NS | -0.12 NS | 0.06 NS | 0.10 NS |  | 0.16 NS | 0.36 \* | 0.44 \*\* | 0.57 \*\* | 0.32 NS | 0.38 \* |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| D/L | *P*N | -0.23 NS | -0.19 NS | 0.28 NS | 0.34 NS | 0.71\*\* | 0.30 NS |  | 0.28 NS | 0.05 NS | -0.14 NS | 0.18 NS | -0.07 NS | 0.18 NS |
| *g*s | -0.00 NS | -0.11 NS | -0.29 NS | -0.04 NS | 0.54 \*\* | 0.36 \* |  | 0.24 NS | 0.25 NS | -0.09 NS | -0.11 NS | -0.19 NS | 0.03 NS |
| *E* | -0.04 NS | -0.28 NS | -0.08 NS | 0.18 NS | 0.24 NS | 0.29 NS |  | -0.02 NS | -0.00 NS | 0.09 NS | 0.03 NS | 0.15 NS | 0.00 NS |
| Leaf greeness | -0.18 NS | -0.15 NS | 0.00 NS | 0.15 NS | 0.26 NS | 0.17 NS |  | 0.27 NS | -0.17 NS | 0.01 NS | -0.04 NS | -0.57 \*\* | 0.31 NS |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| D/Z | *P*N | -0.01 NS | -0.01 NS | -0.11 NS | 0.01 NS | 0.49 \*\* | 0.22 NS |  | 0.43 \* | 0.42 \* | -0.14 NS | -0.00 NS | 0.52 \*\* | 0.60 \*\* |
| *g*s | -0.21 NS | -0.22 NS | -0.23 NS | -0.06 NS | 0.29 NS | 0.25 NS |  | 0.15 NS | 0.15 NS | -0.34 NS | -0.22 NS | 0.29 NS | -0.00 NS |
| *E* | -0.23 NS | -0.26 NS | 0.39 \* | 0.32 NS | 0.22 NS | 0.17 NS |  | 0.18 NS | 0.09 NS | -0.10 NS | -0.21 NS | 0.38 \* | 0.08 NS |
| Leaf greeness | 0.107 NS | 0.295 NS | 0.180 NS | 0.243 NS | -0.05 NS | -0.086 NS |  | 0.050 NS | 0.089 NS | -0.037 NS | 0.132 NS | 0.058 NS | 0.519\*\* |

**R2: the flowering stage; R5: early grain-filing stage; R6: late grain-filling stage. D: mean of eleven common cultivars; D/D: self-grafts; L/D or Z/D: grafts with L14/Z35 scions; D/L or D/Z: grafts with L14/Z35 rootstocks. *P*N: net photosynthetic rate; *g*s: stomatal conductance; *E*: transpiration rate. RA: root activity; RBSM: root bleeding sap mass. \* *P* < 0.05, \*\* *P* < 0.01, NS: not significant.**