**Supplementary Tables and Figures**

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**Figure 1S.** GGEbiplot analysis for genotypes x environments for 62 inbred lines evaluated in Anhembi 2013/14, Anhembi 2014/15, and Piracicaba 2014/15 for nitrogen use efficiency based on yield - NUEP (A), number of ears - EN (B), ear length - EL (C), ear diameter - ED (D), ear weight - EW (E), number of rows per ear - NRE (F), number of kernels per row - NKF (L), and total yield - TY (H). Axial root length - LRAxi (I) is according to Anhembi 2014/15 and Piracicaba 2014/15.

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**Figure 2S.** GGEbiplot analysis for genotypes x environments x nitrogen levels, low (BN) and ideal (IN), for 62 inbred lines evaluated in Anhembi 2013/14, Anhembi 2014/15, and Piracicaba 2014 for nitrogen use efficiency based on yield – NUEP (A) and ear length – EL (B).

**Table 1S**. Direct and indirect effects according to nitrogen levels, low (LN) and ideal (IN), for root, physiological, and reproductive traits depending on nitrogen use efficiency based on yield (NUEP), nitrogen use efficiency in the V8 stage (NUEV8), and nitrogen use efficiency in the VT stage (NUEVT) in tropical maize inbred lines.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| LN | | | | | IN | | | | |
| Trait | Effect | NUEP | NUEV8 | NUEVT | Trait | Effect | NUEP | NUEV8 | NUEVT |
| LRLat |  |  |  |  | LRLat |  |  |  |  |
| Direct |  | -0.33 | 0.18 | 0.52 | Direct |  | -0.56 | 0.30 | 0.52 |
| Indirect |  |  |  |  | Indirect |  |  |  |  |
|  | LRAxi | -0.19 | 0.00 | 0.10 |  | LRAxi | -0.28 | -0.23 | 0.06 |
|  | VRLat | 0.39 | -0.21 | -0.52 |  | VRLat | 0.82 | -0.10 | -0.59 |
|  | VRAxi | 0.14 | 0.34 | 0.09 |  | VRAxi | 0.10 | 0.36 | 0.18 |
|  | PEPSII | 0.00 | 0.00 | 0.00 |  | PEPSII | 0.01 | 0.00 | 0.00 |
|  | ASI | 0.00 | 0.00 | 0.00 |  | ASI | 0.00 | 0.00 | 0.00 |
|  | Total | 0.01 | 0.31 | 0.19 |  | Total | 0.09 | 0.33 | 0.17 |
| LRAxi |  |  |  |  | LRAxi |  |  |  |  |
| Direct |  | 0.26 | 0.00 | 0.14 | Direct |  | -0.40 | -0.31 | 0.09 |
| Indirect |  |  |  |  | Indirect |  |  |  |  |
|  | LRLat | -0.24 | 0.14 | 0.39 |  | LRLat | -0.40 | 0.21 | 0.37 |
|  | VRLat | 0.37 | -0.20 | -0.48 |  | VRLat | 0.76 | -0.10 | -0.55 |
|  | VRAxi | 0.20 | 0.47 | 0.12 |  | VRAxi | 0.14 | 0.48 | 0.25 |
|  | PEPSII | -0.01 | 0.00 | -0.01 |  | PEPSII | 0.02 | 0.00 | 0.00 |
|  | ASI | -0.01 | 0.00 | -0.01 |  | ASI | 0.01 | -0.02 | 0.00 |
|  | Total | 0.57 | 0.41 | 0.15 |  | Total | 0.13 | 0.26 | 0.16 |
| VRLat |  |  |  |  | VRLat |  |  |  |  |
| Direct |  | 0.43 | -0.23 | -0.56 | Direct |  | 0.88 | -0.12 | -0.64 |
| Indirect |  |  |  |  | Indirect |  |  |  |  |
|  | LRLat | -0.30 | 0.17 | 0.48 |  | LRLat | -0.52 | 0.28 | 0.48 |
|  | LRAxi | -0.22 | 0.00 | 0.12 |  | LRAxi | -0.34 | -0.27 | 0.07 |
|  | VRAxi | 0.16 | 0.38 | 0.10 |  | VRAxi | 0.12 | 0.40 | 0.21 |
|  | PEPSII | 0.00 | 0.00 | 0.00 |  | PEPSII | 0.01 | 0.00 | 0.00 |
|  | ASI | -0.01 | 0.00 | -0.01 |  | ASI | 0.00 | -0.01 | 0.00 |
|  | Total | 0.06 | 0.32 | 0.13 |  | Total | 0.15 | 0.28 | 0.12 |
| VRAxi |  |  |  |  | VRAxi |  |  |  |  |
| Direct |  | 0.28 | 0.68 | 0.18 | Direct |  | 0.20 | 0.68 | 0.35 |
| Indirect |  |  |  |  | Indirect |  |  |  |  |
|  | LRLat | -0.16 | 0.09 | 0.27 |  | LRLat | -0.29 | 0.16 | 0.27 |
|  | LRAxi | -0.18 | 0.00 | 0.09 |  | LRAxi | -0.28 | -0.22 | 0.06 |
|  | VRLat | 0.24 | -0.13 | -0.32 |  | VRLat | 0.52 | -0.07 | -0.37 |
|  | PEPSII | -0.02 | 0.00 | -0.02 |  | PEPSII | 0.03 | 0.00 | 0.00 |
|  | ASI | 0.00 | 0.00 | 0.00 |  | ASI | 0.00 | 0.00 | 0.00 |
|  | Total | 0.16 | 0.64 | 0.20 |  | Total | 0.18 | 0.55 | 0.31 |
| PEPSII |  |  |  |  | PEPSII |  |  |  |  |
| Direct |  | 0.11 | -0.01 | 0.09 | Direct |  | 0.13 | 0.00 | 0.00 |
| Indirect |  |  |  |  | Indirect |  |  |  |  |
|  | LRLat | 0.01 | 0.00 | -0.02 |  | LRLat | -0.06 | 0.03 | 0.06 |
|  | LRAxi | 0.02 | 0.00 | -0.01 |  | LRAxi | -0.07 | -0.05 | 0.01 |
|  | VRLat | -0.01 | 0.00 | 0.01 |  | VRLat | 0.09 | -0.01 | -0.06 |
|  | VRAxi | -0.06 | -0.14 | -0.04 |  | VRAxi | 0.04 | 0.14 | 0.07 |
|  | ASI | -0.01 | 0.00 | -0.01 |  | ASI | 0.00 | 0.00 | 0.00 |
|  | Total | -0.06 | -0.15 | 0.02 |  | Total | 0.13 | 0.11 | 0.08 |
| ASI |  |  |  |  | ASI |  |  |  |  |
| Direct |  | -0.07 | 0.00 | -0.04 | Direct |  | 0.02 | -0.12 | 0.00 |
| Indirect |  |  |  |  | Indirect |  |  |  |  |
|  | LRLat | -0.03 | 0.02 | 0.05 |  | LRLat | -0.02 | 0.01 | 0.02 |
|  | LRAxi | -0.04 | 0.00 | 0.02 |  | LRAxi | -0.07 | -0.06 | 0.01 |
|  | VRLat | 0.06 | 0.01 | -0.08 |  | VRLat | 0.10 | -0.01 | -0.07 |
|  | VRAxi | 0.00 | 0.01 | 0.00 |  | VRAxi | 0.00 | -0.01 | 0.00 |
|  | PEPSII | 0.02 | 0.00 | 0.01 |  | PEPSII | 0.00 | 0.00 | 0.00 |
|  | Total | -0.06 | -0.02 | -0.04 |  | Total | 0.03 | -0.19 | -0.04 |
|  | R2 | 0.06 | 0.42 | 0.09 |  | R2 | 0.08 | 0.39 | 0.14 |
| Pɛ | 0.96 | 0.76 | 0.95 | Pɛ | 0.95 | 0.78 | 0.93 |

R2: coefficient of determination; Pɛ: residual effect; Traits: lateral root length (LRLat), axial root length (LRAxi), lateral root volume (VRLat), axial root volume (VRAxi), photosynthetic efficiency of photosystem II (PEPSII) and anthesis-silking interval (ASI)