

Supplementary data

Table S1. PHS tolerance scores of the 194 DH lines across the six environments. An augmented design was used in all environments with a single replicate of each DH line and five replicates of the three parents grown in 1-m rows with an inter-row and intra-row spacing of 0.45 and 0.5 m, respectively.

| †Genotype / Parent | Replicate | ‡Environment | | | | | | AVE_Score |
|--------------------|-----------|--------------|------|------|-------|------|------|-----------|
| | | ARL | BHM3 | BHM4 | CLAR5 | HAR7 | HAR8 | |
| TE1 | 1 | 3 | * | 4 | * | * | 4 | 4 |
| TE2 | 1 | 2 | 6 | 1 | 4 | 4 | 2 | 3 |
| TE3 | 1 | 4 | 4 | 3 | 2 | 2 | 5 | 3 |
| TE4 | 1 | 3 | 2 | 2 | 2 | 6 | 1 | 3 |
| TE5 | 1 | 2 | 3 | 1 | 5 | 4 | 1 | 3 |
| TE6 | 1 | 3 | 4 | 4 | 2 | 2 | 3 | 3 |
| TE7 | 1 | 2 | 2 | 2 | 2 | 4 | 4 | 3 |
| TE8 | 1 | 4 | 2 | 2 | 2 | 4 | 4 | 3 |
| TE9 | 1 | 6 | 6 | * | 4 | 5 | 3 | 5 |
| TE10 | 1 | 5 | * | * | 3 | 5 | 4 | 4 |
| TE11 | 1 | 2 | * | * | * | * | 5 | 3 |
| TE12 | 1 | 5 | 7 | 2 | 4 | 2 | 2 | 4 |
| TE13 | 1 | 5 | * | 1 | * | * | 2 | 3 |
| TE14 | 1 | 3 | 5 | 2 | 5 | 2 | 2 | 3 |
| TE15 | 1 | 4 | * | 3 | 4 | * | * | 4 |
| TE16 | 1 | 5 | 3 | 2 | 4 | 3 | * | 3 |
| TE17 | 1 | 4 | 5 | 3 | 3 | 4 | 5 | 4 |
| TE18 | 1 | 4 | 6 | 4 | 5 | 3 | 2 | 4 |
| TE19 | 1 | 2 | 6 | 1 | 4 | * | * | 3 |
| TE20 | 1 | 3 | 4 | 2 | 2 | 2 | 5 | 3 |
| TE21 | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 2 |
| TE22 | 1 | 4 | 6 | 5 | 2 | 5 | 1 | 4 |
| TE23 | 1 | 2 | 4 | 3 | 1 | 4 | 2 | 3 |
| TE24 | 1 | 5 | 4 | 2 | 2 | 2 | 3 | 3 |
| TE25 | 1 | 4 | 3 | 3 | 6 | 2 | 4 | 4 |
| TE26 | 1 | 5 | 6 | 3 | 3 | 4 | 2 | 4 |
| TE27 | 1 | 2 | 6 | 3 | 4 | 3 | 2 | 3 |
| TE28 | 1 | 5 | 5 | 3 | 3 | 4 | 3 | 4 |
| TE29 | 1 | 4 | 3 | 4 | 3 | 2 | 3 | 3 |
| TE30 | 1 | 3 | 6 | 3 | 3 | 5 | 3 | 4 |
| TE31 | 1 | 2 | * | * | * | * | * | 2 |
| TE32 | 1 | 3 | * | 2 | 3 | 2 | 3 | 3 |
| TE33 | 1 | 3 | * | 4 | * | * | 2 | 3 |
| TE34 | 1 | 3 | 4 | 3 | 2 | 5 | * | 4 |
| TE35 | 1 | 4 | 4 | 4 | 2 | 5 | 2 | 3 |
| TE36 | 1 | 4 | 5 | 3 | 3 | 2 | 1 | 3 |
| TE37 | 1 | 2 | 2 | 2 | 2 | 1 | 4 | 2 |
| TE38 | 1 | 5 | * | * | * | * | 2 | 4 |
| TE40 | 1 | 5 | 6 | 4 | 5 | 3 | 3 | 4 |
| TE41 | 1 | 5 | 6 | 4 | * | * | 1 | 4 |
| TE42 | 1 | * | 4 | 3 | 5 | 4 | 2 | 4 |
| TE43 | 1 | 5 | 6 | 3 | 4 | 5 | 2 | 4 |
| TE44 | 1 | 4 | 4 | 3 | 2 | 3 | 2 | 3 |

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|-------|---|---|---|---|---|---|---|---|
| TE45 | 1 | 4 | 4 | 1 | 1 | 4 | 1 | 2 |
| TE46 | 1 | 3 | 5 | 3 | 3 | 1 | 4 | 3 |
| TE47 | 1 | 2 | * | 3 | 4 | 2 | * | 3 |
| TE48 | 1 | 4 | 6 | 4 | 2 | 5 | 5 | 4 |
| TE49 | 1 | 3 | 5 | 3 | 2 | 4 | 3 | 3 |
| TE50 | 1 | 2 | 5 | 2 | 2 | 4 | * | 3 |
| TE51 | 1 | 2 | 4 | 3 | 3 | 4 | 3 | 3 |
| TE53 | 1 | 2 | 5 | 4 | 3 | 5 | 3 | 4 |
| TE54 | 1 | 2 | 3 | 3 | 1 | 4 | 1 | 2 |
| TE55 | 1 | 3 | 5 | 2 | 3 | 3 | 1 | 3 |
| TE56 | 1 | 4 | 5 | 3 | 3 | 4 | 1 | 3 |
| TE57 | 1 | 3 | 5 | 3 | 4 | 5 | 1 | 4 |
| TE58 | 1 | 4 | * | 1 | 2 | 2 | * | 2 |
| TE59 | 1 | 2 | 3 | 2 | 2 | 3 | 3 | 3 |
| TE60 | 1 | 4 | 4 | 3 | 2 | 4 | 2 | 3 |
| TE61 | 1 | 3 | 6 | 4 | 3 | 4 | 2 | 4 |
| TE62 | 1 | 2 | 2 | 4 | 2 | 2 | 1 | 2 |
| TE63 | 1 | 3 | 3 | 4 | 2 | 3 | 5 | 3 |
| TE64 | 1 | 4 | 5 | 5 | 2 | 5 | 2 | 4 |
| TE66 | 1 | 2 | 4 | 2 | 3 | 2 | 1 | 2 |
| TE67 | 1 | 5 | 6 | 4 | 4 | 6 | 3 | 5 |
| TE68 | 1 | 3 | 5 | 3 | 4 | 3 | 2 | 3 |
| TE69 | 1 | 3 | 3 | 2 | 2 | 2 | 4 | 3 |
| TE70 | 1 | 5 | 3 | 2 | 3 | 4 | 2 | 3 |
| TE71 | 1 | 2 | 3 | 3 | 2 | 3 | 1 | 2 |
| TE73 | 1 | 2 | 3 | 2 | 1 | 3 | 1 | 2 |
| TE74 | 1 | 3 | 2 | 2 | 1 | 3 | 1 | 2 |
| TE75 | 1 | 3 | 3 | 2 | 4 | 3 | 3 | 3 |
| TE76 | 1 | 3 | 4 | 2 | 1 | * | 1 | 2 |
| TE77 | 1 | 5 | 6 | 3 | 3 | 5 | 3 | 4 |
| TE78 | 1 | 3 | 3 | 3 | 2 | 4 | 3 | 3 |
| TE79 | 1 | 3 | 3 | 1 | 2 | 4 | 2 | 2 |
| TE80 | 1 | 4 | 4 | 3 | 3 | 5 | 3 | 4 |
| TE81 | 1 | 5 | 5 | * | 3 | 4 | 2 | 4 |
| TE83 | 1 | 3 | * | * | * | * | * | 3 |
| TE84 | 1 | 3 | 2 | 2 | 3 | 4 | 2 | 3 |
| TE85 | 1 | 4 | 4 | 1 | 2 | 4 | 2 | 3 |
| TE86 | 1 | 3 | 4 | 2 | 3 | 3 | 3 | 3 |
| TE87 | 1 | 4 | 4 | 6 | 3 | 5 | 4 | 4 |
| TE89 | 1 | 2 | 4 | 3 | 3 | * | 4 | 3 |
| TE90 | 1 | 3 | 6 | 1 | 2 | 2 | 2 | 3 |
| TE91 | 1 | 3 | 5 | 3 | 3 | 4 | 3 | 4 |
| TE92 | 1 | 4 | 4 | 4 | 3 | 3 | 5 | 4 |
| TE93 | 1 | 3 | 3 | 2 | 2 | 5 | 1 | 3 |
| TE94 | 1 | 4 | * | 3 | * | * | 2 | 3 |
| TE95 | 1 | 5 | 4 | 4 | 3 | 4 | 4 | 4 |
| TE96 | 1 | 4 | 4 | 3 | 4 | 4 | 1 | 3 |
| TE97 | 1 | 3 | 4 | 2 | 2 | 3 | * | 3 |
| TE98 | 1 | 3 | 4 | 3 | 4 | 3 | 3 | 3 |
| TE99 | 1 | 4 | 5 | 2 | 3 | 6 | 2 | 4 |
| TE101 | 1 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

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|-------|---|---|---|---|---|---|---|---|
| TE102 | 1 | 4 | 6 | 3 | 2 | 5 | 2 | 4 |
| TE103 | 1 | 4 | 5 | 3 | 3 | 3 | 2 | 3 |
| TE104 | 1 | 3 | 4 | 3 | * | 5 | 1 | 3 |
| TE105 | 1 | 2 | 4 | 2 | 2 | 3 | 3 | 3 |
| TE106 | 1 | 4 | * | 4 | 5 | 5 | 4 | 4 |
| TE109 | 1 | * | * | 2 | 4 | * | 1 | 2 |
| TE111 | 1 | 2 | 5 | 4 | * | 2 | 5 | 4 |
| TE112 | 1 | 2 | 6 | 4 | 2 | 3 | * | 3 |
| TE113 | 1 | 3 | 4 | 4 | 2 | 2 | 4 | 3 |
| TE114 | 1 | 4 | 6 | 4 | 2 | 3 | 3 | 4 |
| TE115 | 1 | 2 | 6 | 2 | * | 2 | 2 | 3 |
| TE116 | 1 | 3 | 5 | 4 | * | 2 | * | 4 |
| TE118 | 1 | * | * | 3 | 2 | * | 2 | 2 |
| TE119 | 1 | * | 6 | 2 | * | 5 | * | 4 |
| TE120 | 1 | 3 | 3 | 4 | 4 | 4 | * | 3 |
| TE122 | 1 | 2 | 4 | 1 | 1 | 2 | 1 | 2 |
| TE123 | 1 | 4 | 4 | 3 | 3 | 5 | 4 | 4 |
| TE124 | 1 | 2 | 2 | 3 | 3 | 1 | 5 | 3 |
| TE125 | 1 | 3 | 7 | 2 | * | 2 | 3 | 3 |
| TE126 | 1 | 4 | 5 | 3 | 3 | 2 | 5 | 4 |
| TE127 | 1 | 1 | 3 | 2 | 2 | 2 | 4 | 2 |
| TE128 | 1 | 4 | 4 | 2 | 2 | 4 | 2 | 3 |
| TE129 | 1 | 3 | 4 | 4 | 4 | 3 | 4 | 4 |
| TE130 | 1 | 3 | 3 | 3 | 3 | 5 | 2 | 3 |
| TE131 | 1 | 3 | 3 | 4 | 3 | * | 2 | 3 |
| TE132 | 1 | 2 | 5 | 3 | 2 | 3 | 2 | 3 |
| TE133 | 1 | 3 | 6 | 3 | 2 | 3 | 3 | 3 |
| TE135 | 1 | 2 | 2 | 2 | 2 | * | 1 | 2 |
| TE136 | 1 | 2 | 5 | 2 | * | 3 | * | 3 |
| TE139 | 1 | 3 | 4 | 4 | 3 | 4 | 4 | 4 |
| TE140 | 1 | 4 | 5 | 3 | 4 | 4 | 5 | 4 |
| TE141 | 1 | 3 | 4 | 4 | 3 | 3 | * | 3 |
| TE142 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| TE144 | 1 | 4 | 6 | 3 | 4 | 5 | 1 | 4 |
| TE145 | 1 | 5 | 4 | 5 | 4 | 5 | 2 | 4 |
| TE146 | 1 | 3 | 7 | 4 | 4 | * | 2 | 4 |
| TE147 | 1 | 4 | 5 | 3 | 3 | 5 | 2 | 4 |
| TE148 | 1 | 5 | 7 | 4 | 3 | 5 | 1 | 4 |
| TE149 | 1 | 5 | 5 | 6 | 5 | 6 | 5 | 5 |
| TE150 | 1 | 4 | 6 | 4 | 4 | 6 | 2 | 4 |
| TE151 | 1 | 4 | 8 | 4 | 1 | 2 | 2 | 3 |
| TE152 | 1 | 3 | 5 | 5 | 6 | 2 | 4 | 4 |
| TE153 | 1 | 3 | 6 | 3 | 2 | 4 | 1 | 3 |
| TE155 | 1 | 4 | 6 | 3 | 4 | 6 | 5 | 5 |
| TE158 | 1 | 4 | 7 | * | 4 | 2 | * | 4 |
| EF1 | 1 | * | 3 | 2 | 2 | 3 | 2 | 2 |
| EF3 | 1 | * | 5 | 3 | 2 | 4 | 2 | 3 |
| EF4 | 1 | * | 6 | 4 | 2 | 5 | 4 | 4 |
| EF6 | 1 | * | * | 3 | * | * | 3 | 3 |
| EF7 | 1 | * | 4 | * | 1 | 2 | 2 | 2 |
| EF8 | 1 | * | 4 | 3 | 3 | 1 | 4 | 3 |

| | | | | | | | | |
|-----------|---|---|---|---|---|---|---|---|
| EF9 | 1 | * | 3 | 3 | 2 | 2 | 1 | 2 |
| EF10 | 1 | * | 5 | 5 | 3 | 5 | 2 | 4 |
| EF11 | 1 | * | 5 | 1 | * | 1 | 2 | 2 |
| EF12 | 1 | * | 5 | 1 | * | 3 | 3 | 3 |
| EF13 | 1 | * | 5 | 1 | * | 1 | 3 | 3 |
| EF14 | 1 | * | 5 | 1 | * | 2 | 3 | 3 |
| EF15 | 1 | * | 2 | 2 | 1 | 1 | 4 | 2 |
| EF16 | 1 | * | 5 | 2 | 3 | 2 | 3 | 3 |
| EF17 | 1 | * | 2 | 1 | 1 | 2 | 5 | 2 |
| EF18 | 1 | * | 4 | 3 | 3 | 2 | 5 | 3 |
| EF19 | 1 | * | 5 | 2 | * | 1 | 2 | 3 |
| EF20 | 1 | * | 5 | 3 | 1 | 5 | * | 4 |
| EF21 | 1 | * | 6 | 3 | 2 | 5 | * | 4 |
| EF22 | 1 | * | 2 | * | * | 2 | 2 | 2 |
| EF23 | 1 | * | 4 | 3 | 1 | 3 | 2 | 3 |
| EF24 | 1 | * | 6 | 5 | * | 5 | 2 | 4 |
| EF25 | 1 | * | 5 | 4 | 2 | 6 | 2 | 4 |
| EF26 | 1 | * | 4 | 3 | * | 3 | 1 | 3 |
| EF27 | 1 | * | 4 | 2 | * | 4 | 3 | 3 |
| EF28 | 1 | * | 5 | 4 | * | 3 | 2 | 4 |
| EF29 | 1 | * | 4 | 3 | 3 | 2 | 2 | 3 |
| EF30 | 1 | * | 4 | 2 | 2 | 3 | 5 | 3 |
| EF31 | 1 | * | 4 | 2 | 1 | 4 | 3 | 3 |
| EF32 | 1 | * | 4 | 4 | 3 | 2 | 3 | 3 |
| EF34 | 1 | * | 5 | 2 | * | 1 | 1 | 2 |
| EF35 | 1 | * | 4 | 3 | 2 | 2 | 2 | 3 |
| EF37 | 1 | * | 5 | 3 | 4 | 2 | 1 | 3 |
| EF38 | 1 | * | 5 | 3 | 2 | 4 | * | 3 |
| EF39 | 1 | * | 4 | 2 | * | 2 | * | 3 |
| EF40 | 1 | * | 4 | 1 | 1 | 3 | 2 | 2 |
| EF41 | 1 | * | 5 | 3 | 2 | 2 | * | 3 |
| EF42 | 1 | * | 6 | 3 | 1 | 3 | 4 | 3 |
| EF43 | 1 | * | 5 | 4 | 3 | 2 | 6 | 4 |
| EF44 | 1 | * | 2 | 1 | 2 | 2 | 1 | 1 |
| EF45 | 1 | * | 3 | 2 | * | 1 | 2 | 2 |
| EF46 | 1 | * | 5 | 2 | 1 | 3 | 1 | 2 |
| EF47 | 1 | * | 4 | 1 | 1 | 1 | 1 | 2 |
| EF48 | 1 | * | 3 | 1 | * | 3 | 2 | 2 |
| EF49 | 1 | * | 5 | 1 | 5 | 4 | * | 4 |
| EF50 | 1 | * | 5 | 2 | 4 | * | 1 | 3 |
| EF51 | 1 | * | 4 | 4 | 2 | 4 | 5 | 4 |
| EF53 | 1 | * | 5 | 2 | 3 | 2 | 2 | 3 |
| EF54 | 1 | * | 5 | 3 | * | 4 | 3 | 4 |
| EF55 | 1 | * | 5 | 4 | 2 | 3 | * | 4 |
| EF56 | 1 | * | 3 | 3 | 2 | 3 | * | 3 |
| EF57 | 1 | * | 3 | 2 | 2 | 2 | 4 | 3 |
| EF58 | 1 | * | 5 | 2 | 3 | 2 | * | 3 |
| EF59 | 1 | * | 4 | 3 | 3 | 3 | * | 3 |
| EF65 | 1 | * | 6 | 3 | * | 2 | 4 | 4 |
| Tugela-Dn | 1 | 3 | 6 | 5 | 4 | 5 | 4 | 5 |
| Elands | 1 | 3 | 3 | 2 | 1 | 1 | 1 | 2 |

| | | | | | | | | |
|-----------|---|---|---|---|---|---|---|---|
| Flamink | 1 | * | 6 | 3 | 3 | 4 | 1 | 3 |
| Tugela-Dn | 2 | 3 | 6 | 5 | 5 | 5 | 5 | 5 |
| Elands | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 |
| Flamink | 2 | * | 4 | 3 | 3 | 4 | 3 | 3 |
| Tugela-Dn | 3 | 5 | 4 | * | 5 | 6 | 4 | 5 |
| Elands | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 3 |
| Flamink | 3 | * | 5 | 3 | 3 | * | 2 | 3 |
| Tugela-Dn | 4 | 5 | 7 | 5 | 4 | 3 | 6 | 5 |
| Elands | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Flamink | 4 | * | 6 | 3 | * | * | 2 | 4 |
| Tugela-Dn | 5 | 5 | 7 | 6 | 7 | 6 | * | 6 |
| Elands | 5 | 2 | 2 | 3 | 1 | 3 | * | 2 |
| Flamink | 5 | * | 5 | 3 | * | * | 2 | 3 |

†Genotype denotes a DH line. TE denotes a Tugela-Dn × Elands DH line, while EF denotes an Elands × Flamink DH line. Parent denotes the three parental cultivars i.e. Elands, Flamink and Tugela-Dn

‡Environment denotes ARL1 for Arlington 2016, BHM3 for Bethlehem 2016, BHM4 for Bethlehem 2017, CLAR5 for Clarens 2016, HAR7 for Harrismith 2016, and HAR8 for Harrismith 2017.