

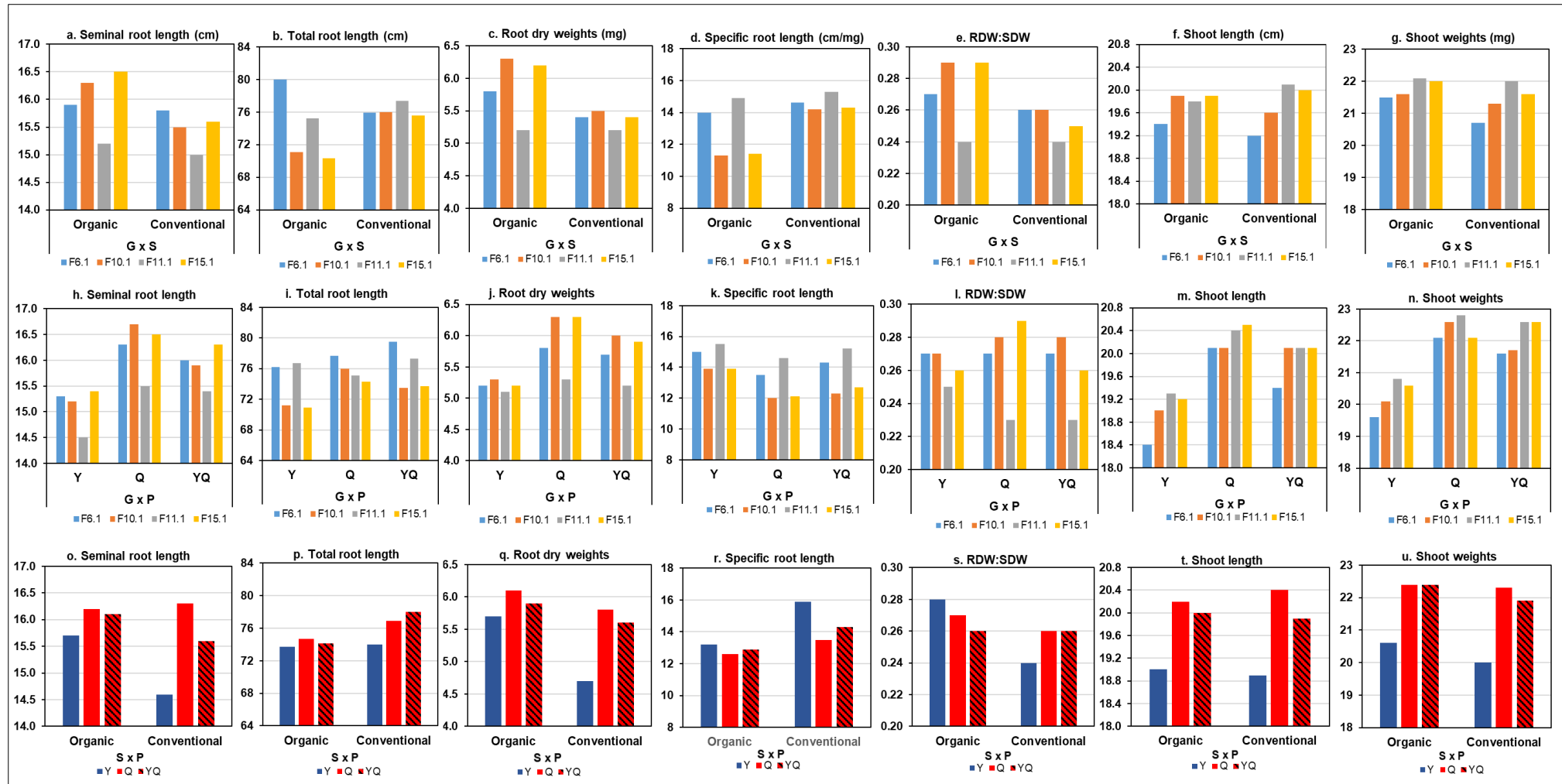
**Effects of ten years organic and conventional farming on early seedling traits of evolving winter wheat composite cross populations**

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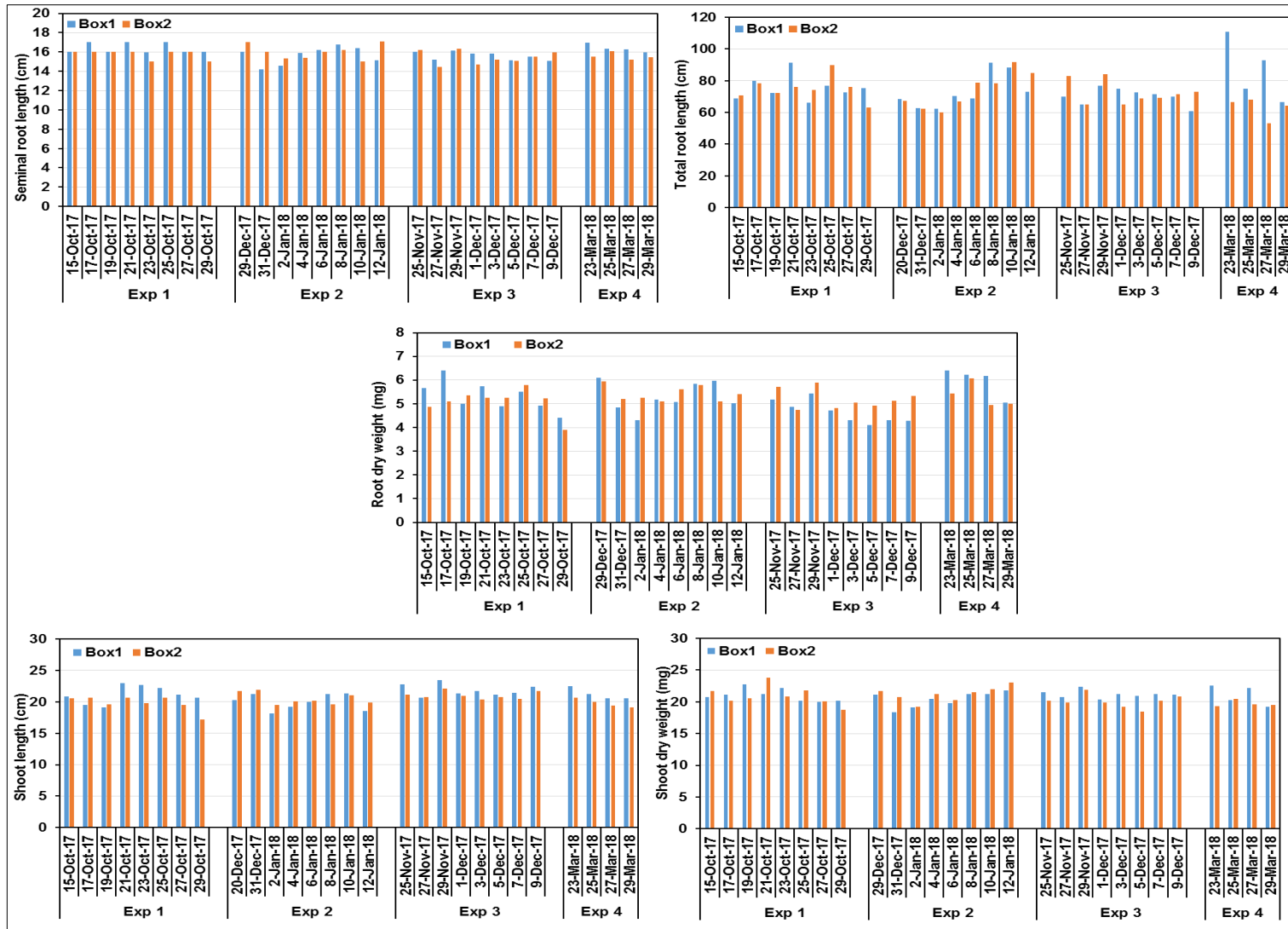
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**Figure S1:** Absolute mean values for seedling traits of CCPs of the F<sub>6.1</sub>, F<sub>10.1</sub>, F<sub>11.1</sub>, and F<sub>15.1</sub> as affected by the interactions of generation (G), system (S) and population (P). Y: yield CCPs, Q: quality CCPs and YQ: yield by quality intercrossed CCPs



**Figure S2:** Mean values for seedling traits of reference varieties, Achat and Tobias per box. Experimental (Exp) periods are:  $F_6$  and  $F_{6.1}$  = Exp 1,  $F_{11}$  and  $F_{11.1}$  = Exp 2,  $F_{10}$  and  $F_{10.1}$  = Exp 3, and only  $F_{15.1}$  = Exp 4

**Table S1.** Mean squares (MS) from analysis of variance of germination of seeds of CCPs of the F<sub>6</sub>, F<sub>10</sub>, and F<sub>11</sub> grown in 2007, 2011, 2012 in organic and conventional fields and stored frozen for 10, 6, and 5 years, respectively and the F<sub>6.1</sub>, F<sub>10.1</sub>, F<sub>11.1</sub> and F<sub>15.1</sub> grown in 2017 in a common conventional field. In addition, the MS for the comparisons among the fresh seeds are given (right column).

|                | F <sub>6</sub> versus F <sub>6.1</sub> (10 years frozen) |      |      |       |      | F <sub>10</sub> and F <sub>10.1</sub> (6 years frozen) |      |       |      | F <sub>11</sub> and F <sub>11.1</sub> (5 years frozen) |     |       |     | F <sub>6.1</sub> F <sub>10.1</sub> , F <sub>11.1</sub> and F <sub>15.1</sub> |      |       |      |     |
|----------------|----------------------------------------------------------|------|------|-------|------|--------------------------------------------------------|------|-------|------|--------------------------------------------------------|-----|-------|-----|------------------------------------------------------------------------------|------|-------|------|-----|
|                | Day 4                                                    |      |      | Day 8 |      | Day 4                                                  |      | Day 8 |      | Day 4                                                  |     | Day 8 |     | Day 4                                                                        |      | Day 8 |      |     |
|                | DF                                                       | MS   | P    | MS    | P    | MS                                                     | P    | MS    | P    | MS                                                     | P   | MS    | P   | DF                                                                           | MS   | P     | MS   | P   |
| Generation (G) | 1                                                        | 0.09 | 0.5  | 1.0   | 0.09 | 0.8                                                    | 0.09 | 1.0   | 0.06 | 0.01                                                   | 0.9 | 0.04  | 0.7 | 3                                                                            | 0.7  | 0.3   | 0.3  | 0.4 |
| System (S)     | 1                                                        | 0.8  | 0.09 | 1.0   | 0.09 | 0.09                                                   | 0.5  | 0.0   | 1.0  | 0.09                                                   | 0.7 | 0.4   | 0.3 | 1                                                                            | 0.3  | 0.4   | 0.02 | 0.8 |
| Population (P) | 2                                                        | 0.3  | 0.3  | 0.07  | 0.8  | 0.2                                                    | 0.4  | 0.4   | 0.3  | 0.3                                                    | 0.7 | 0.2   | 0.5 | 2                                                                            | 0.4  | 0.4   | 0.1  | 0.7 |
| G x S          | 1                                                        | 0.3  | 0.3  | 0.2   | 0.5  | 0.09                                                   | 0.5  | 0.2   | 0.4  | 0.8                                                    | 0.3 | 0.04  | 0.7 | 3                                                                            | 0.04 | 1.0   | 0.3  | 0.4 |
| G x P          | 2                                                        | 0.1  | 0.6  | 0.4   | 0.3  | 0.03                                                   | 0.9  | 0.07  | 0.8  | 0.8                                                    | 0.4 | 0.07  | 0.8 | 6                                                                            | 0.4  | 0.5   | 0.1  | 0.8 |
| S x P          | 2                                                        | 0.1  | 0.6  | 0.07  | 0.8  | 0.09                                                   | 0.7  | 0.09  | 0.7  | 0.2                                                    | 0.7 | 0.09  | 0.7 | 2                                                                            | 0.1  | 0.8   | 0.1  | 0.7 |
| G x S x P      | 2                                                        | 0.04 | 0.8  | 0.4   | 0.3  | 0.03                                                   | 0.9  | 0.07  | 0.8  | 0.7                                                    | 0.4 | 0.07  | 0.8 | 6                                                                            | 0.3  | 0.7   | 0.09 | 0.9 |

**Table S2.** Analysis of covariance of seed size with seedling traits in the seeds of CCPs of F<sub>6</sub>, F<sub>10</sub> and F<sub>11</sub> grown in 2007, 2011 and 2012 in organic and conventional fields, respectively and F<sub>6.1</sub>, F<sub>10.1</sub>, F<sub>11.1</sub>, and F<sub>15.1</sub> grown in 2017 in a common conventional field.

|                                                                                | SRL            |        | TRL            |        | RDW            |        | SL             |      | SDW            |        | SpecificRL     |      | RDW:SDW        |      |
|--------------------------------------------------------------------------------|----------------|--------|----------------|--------|----------------|--------|----------------|------|----------------|--------|----------------|------|----------------|------|
|                                                                                | r <sup>2</sup> | P      | r <sup>2</sup> | P      | r <sup>2</sup> | P      | r <sup>2</sup> | P    | r <sup>2</sup> | P      | r <sup>2</sup> | P    | r <sup>2</sup> | P    |
| F <sub>6</sub> and F <sub>6.1</sub>                                            | 0.13           | <0.001 | 0.14           | <0.001 | 0.04           | 0.004  | 0.001          | 0.62 | 0.03           | 0.011  |                |      |                |      |
| F <sub>10</sub> and F <sub>10.1</sub>                                          | 0.002          | 0.54   | 0.19           | 0.06   | 0.14           | <0.001 | 0.016          | 0.08 | 0.06           | <0.001 |                |      |                |      |
| F <sub>11</sub> and F <sub>11.1</sub>                                          | 0.04           | 0.004  | 0.00001        | 0.96   | 0.0004         | 0.79   | 0.002          | 0.54 | 0.03           | 0.02   |                |      |                |      |
| F <sub>6.1</sub> , F <sub>10.1</sub> , F <sub>11.1</sub> and F <sub>15.1</sub> | 0.015          | 0.02   | 0.002          | 0.44   | 0.005          | 0.19   | 0.009          | 0.06 | 0.05           | <0.001 | 0.001          | 0.57 | 0.003          | 0.30 |

SRL - seminal root length; TRL – total root length; RDW– root dry weight; SL – shoot length; SDW –shoot dry weight; SpecificRL - specific root length calculated as TRL/RDW; and RDW:SDW - root:shoot ratio.

**Table S3.** Effects of organic and conventional farming systems on early seedling traits of the CCPs of the F<sub>6</sub>, F<sub>10</sub>, and F<sub>11</sub> grown in 2007, 2011, 2012 in organic and conventional fields and stored frozen for 10, 6, and 5 years, respectively and the F<sub>6.1</sub>, F<sub>10.1</sub>, and F<sub>11.1</sub> grown in 2017 in a common conventional field. Relative and absolute (in parentheses) values are shown. Significant results are given in bold.

|              | SRL (cm)                       |                               | TRL (cm)                      |                               | SL (cm)                       |                               | RDW (mg)                      |                               | SDW (mg)                      |                                |
|--------------|--------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------------|
|              | F <sub>6</sub>                 | F <sub>6.1</sub>              | F <sub>6</sub>                | F <sub>6.1</sub>              | F <sub>6</sub>                | F <sub>6.1</sub>              | F <sub>6</sub>                | F <sub>6.1</sub>              | F <sub>6</sub>                | F <sub>6.1</sub>               |
| <b>G x S</b> |                                |                               |                               |                               |                               |                               |                               |                               |                               |                                |
| Organic      | 0.95<br>(14.7)                 | 0.98<br>(16.0)                | 0.90<br>(63.3)                | 1.06<br>(80.2)                | 0.88<br>(19.3)                | 0.92<br>(19.4)                | 1.15<br>(5.3)                 | 1.10<br>(5.8)                 | <b>0.91b</b><br><b>(19.2)</b> | <b>1.02a</b><br><b>(21.5)</b>  |
| Conventional | 0.95<br>(14.6)                 | 0.97<br>(15.8)                | 0.86<br>(60.5)                | 1.01<br>(75.9)                | 0.91<br>(19.9)                | 0.91<br>(19.2)                | 1.14<br>(5.3)                 | 1.01<br>(5.4)                 | <b>0.93b</b><br><b>(19.7)</b> | <b>0.99a</b><br><b>(20.7)</b>  |
| <i>Mean</i>  | <b>0.95b</b><br><b>(14.7)</b>  | <b>0.98a</b><br><b>(15.9)</b> | <b>0.88b</b><br><b>(61.9)</b> | <b>1.04a</b><br><b>(78.1)</b> | 0.90<br>(19.6)                | 0.92<br>(19.3)                | 1.15<br>(5.3)                 | 1.06<br>(5.6)                 | <b>0.92b</b><br><b>(19.5)</b> | <b>1.01a</b><br><b>(21.1)</b>  |
|              | F <sub>10</sub>                | F <sub>10.1</sub>             | F <sub>10</sub>               | F <sub>10.1</sub>             | F <sub>10</sub>               | F <sub>10.1</sub>             | F <sub>10</sub>               | F <sub>10.1</sub>             | F <sub>10</sub>               | F <sub>10.1</sub>              |
| <b>G x S</b> |                                |                               |                               |                               |                               |                               |                               |                               |                               |                                |
| Organic      | <b>0.99b</b><br><b>(15.7)</b>  | <b>1.04a</b><br><b>(16.3)</b> | 1.07<br>(77.0)                | 0.97<br>(71.1)                | <b>0.93b</b><br><b>(18.9)</b> | <b>1.00a</b><br><b>(19.9)</b> | <b>1.17a</b><br><b>(6.6)</b>  | <b>1.20a</b><br><b>(6.3)</b>  | <b>1.08b</b><br><b>(22.0)</b> | <b>1.06b</b><br><b>(21.6)</b>  |
| Conventional | <b>1.01b</b><br><b>(16.1)</b>  | <b>0.99b</b><br><b>(15.5)</b> | 1.07<br>(77.3)                | 1.04<br>(76.0)                | <b>0.97a</b><br><b>(19.8)</b> | <b>0.98a</b><br><b>(19.6)</b> | <b>1.14a</b><br><b>(6.4)</b>  | <b>1.04b</b><br><b>(5.5)</b>  | <b>1.14a</b><br><b>(23.2)</b> | <b>1.05b</b><br><b>(21.3)</b>  |
| <i>Mean</i>  | 1.00<br>(15.9)                 | 1.02<br>(15.9)                | 1.07<br>(77.2)                | 1.01<br>(73.6)                | 0.95<br>(19.4)                | 0.99<br>(19.8)                | 1.16<br>(6.5)                 | 1.12<br>(5.9)                 | 1.11<br>(22.6)                | 1.06<br>(21.5)                 |
| <b>G x P</b> |                                |                               |                               |                               |                               |                               |                               |                               |                               |                                |
| Y            | <b>0.97c</b><br><b>(15.5)</b>  | <b>0.97c</b><br><b>(15.2)</b> | 1.08<br>(77.9)                | 0.98<br>(71.2)                | <b>0.89c</b><br><b>(18.2)</b> | <b>0.95b</b><br><b>(19.0)</b> | <b>1.11b</b><br><b>(6.3)</b>  | <b>1.01c</b><br><b>(5.3)</b>  | <b>1.07b</b><br><b>(21.7)</b> | <b>0.99c</b><br><b>(20.1)</b>  |
| Q            | <b>1.02b</b><br><b>(16.2)</b>  | <b>1.07a</b><br><b>(16.7)</b> | 1.06<br>(75.9)                | 1.03<br>(76.0)                | <b>1.00a</b><br><b>(20.4)</b> | <b>1.01a</b><br><b>(20.1)</b> | <b>1.19ab</b><br><b>(6.7)</b> | <b>1.20a</b><br><b>(6.3)</b>  | <b>1.14a</b><br><b>(23.3)</b> | <b>1.11ab</b><br><b>(22.6)</b> |
| YQ           | <b>1.00bc</b><br><b>(16.0)</b> | <b>1.02b</b><br><b>(15.9)</b> | 1.08<br>(77.6)                | 1.00<br>(73.5)                | <b>0.95b</b><br><b>(19.4)</b> | <b>1.01a</b><br><b>(20.1)</b> | <b>1.17ab</b><br><b>(6.6)</b> | <b>1.14ab</b><br><b>(6.0)</b> | <b>1.12a</b><br><b>(22.8)</b> | <b>1.07b</b><br><b>(21.7)</b>  |
|              | F <sub>11</sub>                | F <sub>11.1</sub>             | F <sub>11</sub>               | F <sub>11.1</sub>             | F <sub>11</sub>               | F <sub>11.1</sub>             | F <sub>11</sub>               | F <sub>11.1</sub>             | F <sub>11</sub>               | F <sub>11.1</sub>              |
| <b>G x S</b> |                                |                               |                               |                               |                               |                               |                               |                               |                               |                                |
| Organic      | 1.00<br>(15.5)                 | 0.97<br>(15.2)                | <b>0.89b</b><br><b>(64.9)</b> | <b>1.00a</b><br><b>(75.2)</b> | 0.96<br>(20.2)                | 1.00<br>(19.8)                | 1.08<br>(5.6)                 | 1.02<br>(5.2)                 | 1.12<br>(22.5)                | 1.06<br>(22.1)                 |
| Conventional | 0.96<br>(14.9)                 | 0.96<br>(15.0)                | <b>0.87b</b><br><b>(63.1)</b> | <b>1.03a</b><br><b>(77.4)</b> | 0.95<br>(20.0)                | 1.02<br>(20.1)                | 1.07<br>(5.6)                 | 1.02<br>(5.2)                 | 1.07<br>(21.5)                | 1.05<br>(22.0)                 |
| <i>Mean</i>  | 0.98<br>(15.2)                 | 0.97<br>(15.1)                | <b>0.88b</b><br><b>(64.1)</b> | <b>1.02a</b><br><b>(76.3)</b> | 0.96<br>(20.1)                | 1.01<br>(20.0)                | 1.08<br>(5.6)                 | 1.02<br>(5.2)                 | 1.10<br>(22.0)                | 1.06<br>(22.1)                 |

Means followed by different letters within a column of System and Population are significantly different ( $P < 0.05$ ).

G x S: Generation x System; G x P: Generation x Populations;

Y: yield CCPs, Q: quality CCPs and YQ: yield by quality intercrossed CCPs

SRL - seminal root length; TRL – total root length; SL – shoot length; RDW– root dry weight; SDW –shoot dry weight