

**Stojanova B., Münzbergová Z. & Pánková H. (2021) Inbreeding depression and heterosis vary in space and time in the serpentinophyte perennial *Minuartia smejkalii*. – Preslia 93: 149–168.**

**Electronic appendices**

Electronic Appendix 1. – Analyses of late cycle traits for the complete dataset (full model, without effects of sire). Significant values are in bold and significant values after correction for multiple comparisons in a model (31 in total) are underlined. Sample sizes are given in brackets next to the variable name. Flower production was analyzed with a logistic regression, all other traits were long-transformed and analyzed with a linear regression. Flower number is a data subset of plants that produced at least one flower. Dam – pollen recipient (nested in population).

| Variable                                   | DF | Width (1679) |                  | N° stems (1672) |                  | Flower set (1653) |                  | Flower number (1450) |                  | Flower production (1672) |                  |
|--|----|--------------|------------------|-----------------|------------------|-------------------|------------------|----------------------|------------------|--------------------------|------------------|
|  |    | Dev          | p-value          | Dev             | p-value          | Dev               | p-value          | Dev                  | p-value          | Dev                      | p-value          |
| Treatment                                  | 2  | 52.8         | <u>&lt;0.001</u> | 189.0           | <u>&lt;0.001</u> | 155.9             | <u>&lt;0.001</u> | 190.6                | <u>&lt;0.001</u> | 29.4                     | <u>&lt;0.001</u> |
| Soil                                       | 1  | 350.7        | <u>&lt;0.001</u> | 446.9           | <u>&lt;0.001</u> | 415.7             | <u>&lt;0.001</u> | 258.4                | <u>&lt;0.001</u> | 187.4                    | <u>&lt;0.001</u> |
| Pop  | 2  | 14.5         | <u>&lt;0.001</u> | 9.6             | <b>0.0083</b>    | 65.4              | <u>&lt;0.001</u> | 17.7                 | <u>&lt;0.001</u> | 52.8                     | <u>&lt;0.001</u> |
| Cross type                                 | 4  | 133.6        | <u>&lt;0.001</u> | 106.4           | <u>&lt;0.001</u> | 44.7              | <u>&lt;0.001</u> | 76.7                 | <u>&lt;0.001</u> | 12.9                     | <b>0.0117</b>    |
| Year                                       | 1  | 4.8          | <b>0.0285</b>    | 879.9           | <u>&lt;0.001</u> | 446.8             | <u>&lt;0.001</u> | 226.0                | <u>&lt;0.001</u> | 258.4                    | <u>&lt;0.001</u> |
| Dam <sub>pop</sub>                         | 21 | 59.8         | <u>&lt;0.001</u> | 61.7            | <u>&lt;0.001</u> | 70.3              | <u>&lt;0.001</u> | 52.5                 | <u>&lt;0.001</u> | 5.3                      | <u>&lt;0.001</u> |
| Treatment x Soil                           | 2  | 43.9         | <u>&lt;0.001</u> | 26.0            | <u>&lt;0.001</u> | 44.2              | <u>&lt;0.001</u> | 40.2                 | <u>&lt;0.001</u> | 5.0                      | 0.0698           |
| Treatment x Pop                            | 4  | 8.2          | 0.0837           | 0.7             | 0.9490           | 9.4               | 0.0527           | 5.2                  | 0.2641           | 4.8                      | 0.2869           |
| Treatment x Cross type                     | 8  | 15.7         | <b>0.0461</b>    | 12.0            | 0.1490           | 4.8               | 0.7739           | 7.6                  | 0.4750           | 6.1                      | 0.7834           |
| Treatment x Year                           | 2  | 23.6         | <u>&lt;0.001</u> | 19.7            | <u>&lt;0.001</u> | 15.9              | <u>&lt;0.001</u> | 25.3                 | <u>&lt;0.001</u> | 0.7                      | <b>0.0467</b>    |
| Soil x Pop                                 | 2  | 6.1          | <b>0.0478</b>    | 0.8             | 0.6756           | 0.1               | 0.9377           | 1.3                  | 0.5182           | 9.3                      | 0.7091           |
| Soil x Cross type                          | 4  | 13.3         | <b>0.0099</b>    | 10.2            | <b>0.0368</b>    | 11.7              | <b>0.0195</b>    | 1.4                  | 0.8428           | 35.6                     | 0.0536           |
| Soil x Year                                | 1  | 480.5        | <u>&lt;0.001</u> | 445.1           | <u>&lt;0.001</u> | 633.6             | <u>&lt;0.001</u> | 454.9                | <u>&lt;0.001</u> | 26.6                     | <u>&lt;0.001</u> |
| Pop x Cross type                           | 5  | 26.6         | <u>&lt;0.001</u> | 20.6            | <b>0.0010</b>    | 29.7              | <u>&lt;0.001</u> | 8.1                  | 0.1534           | 13.8                     | <u>&lt;0.001</u> |
| Pop x Year                                 | 2  | 135.4        | <u>&lt;0.001</u> | 77.6            | <u>&lt;0.001</u> | 105.1             | <u>&lt;0.001</u> | 60.1                 | <u>&lt;0.001</u> | 9.1                      | <b>0.0010</b>    |
| Cross type x Year                          | 4  | 21.0         | <u>&lt;0.001</u> | 6.1             | 0.1897           | 20.6              | <u>&lt;0.001</u> | 19.7                 | <u>&lt;0.001</u> | 52.3                     | 0.0590           |
| Treatment x Soil x Pop                     | 4  | 2.6          | 0.6233           | 6.2             | 0.1871           | 4.6               | 0.3289           | 8.2                  | 0.0838           | -                        | -                |
| Treatment x Soil x Cross type              | 8  | 12.5         | 0.1284           | 9.6             | 0.2919           | 7.6               | 0.4751           | 12.3                 | 0.1375           | -                        | -                |
| Treatment x Soil x Year                    | 2  | 3.8          | 0.1513           | 2.5             | 0.2923           | 3.9               | 0.1424           | 7.3                  | <b>0.0257</b>    | -                        | -                |
| Treatment x Pop x Cross type               | 9  | 9.7          | 0.3772           | 17.8            | <b>0.0381</b>    | 12.7              | 0.1763           | 12.7                 | 0.1746           | -                        | -                |
| Treatment x Pop x Year                     | 4  | 12.7         | <b>0.0128</b>    | 8.0             | 0.0926           | 11.2              | <b>0.0247</b>    | 28.9                 | <u>&lt;0.001</u> | -                        | -                |
| Treatment x Cross type x Year              | 8  | 6.5          | 0.5937           | 11.0            | 0.1990           | 20.3              | <b>0.0093</b>    | 27.1                 | <u>&lt;0.001</u> | -                        | -                |
| Soil x Pop x Cross type                    | 5  | 3.9          | 0.5611           | 5.0             | 0.4146           | 6.2               | 0.2890           | 6.2                  | 0.2901           | -                        | -                |
| Soil x Pop x Year                          | 2  | 23.8         | <u>&lt;0.001</u> | 8.1             | <b>0.0178</b>    | 3.3               | 0.1911           | 5.8                  | 0.0547           | -                        | -                |
| Soil x Cross type x Year                   | 4  | 10.2         | <b>0.0367</b>    | 7.7             | 0.1026           | 12.7              | <b>0.0129</b>    | 1.2                  | 0.8788           | -                        | -                |
| Pop x Cross type x Year                    | 5  | 34.6         | <u>&lt;0.001</u> | 28.5            | <u>&lt;0.001</u> | 35.9              | <u>&lt;0.001</u> | 14.9                 | <b>0.0108</b>    | -                        | -                |
| Treatment x Soil x Pop x Cross type        | 7  | 7.4          | 0.3918           | 11.3            | 0.1256           | 7.5               | 0.3791           | 18.3                 | <b>0.0109</b>    | -                        | -                |
| Treatment x Soil x Pop x Year              | 4  | 4.5          | 0.3480           | 8.5             | 0.0736           | 23.5              | <u>&lt;0.001</u> | 11.2                 | <b>0.0247</b>    | -                        | -                |
| Treatment x Soil x Cross type x Year       | 8  | 13.4         | 0.0974           | 5.1             | 0.7471           | 10.0              | 0.2677           | 17.5                 | <b>0.0252</b>    | -                        | -                |
| Treatment x Pop x Cross type x Year        | 9  | 7.9          | 0.5406           | 9.6             | 0.3807           | 12.7              | 0.1754           | 16.5                 | <b>0.0359</b>    | -                        | -                |
| Soil x Pop x Cross type x Year             | 5  | 8.4          | 0.1371           | 4.3             | 0.5134           | 19.1              | <b>0.0018</b>    | 21.3                 | <u>&lt;0.001</u> | -                        | -                |
| Treatment x Soil x Pop x Cross type x Year | 7  | 4.0          | 0.7768           | 5.2             | 0.6316           | 5.8               | 0.5628           | 11.7                 | <b>0.0194</b>    | -                        | -                |

Electronic Appendix 2. – Analyses of late cycle traits for the full-sib data subset (full model, with sire). Significant values are in bold and significant values after correction for multiple comparisons in a model (32 in total) are underlined. Sample sizes are given in brackets next to the variable name. All traits were long-transformed and analyzed with a linear regression. Flower number is a data subset of plants that produced at least one flower. Dam – pollen recipient (nested in population), Sire – pollen donor (nested in population).

| Variable                                   | DF | Width (1264) |                         | N° stems (1259) |                         | Flower set (1242) |                         | Flower number (1080) |                         |
|--|----|--------------|-------------------------|-----------------|-------------------------|-------------------|-------------------------|----------------------|-------------------------|
|  |    | Dev          | p-value                 | Dev             | p-value                 | Dev               | p-value                 | Dev                  | p-value                 |
| Treatment                                  | 2  | 41.5         | <b><u>&lt;0.001</u></b> | 144.3           | <b><u>&lt;0.001</u></b> | 121.4             | <b><u>&lt;0.001</u></b> | 135.0                | <b><u>&lt;0.001</u></b> |
| Soil                                       | 1  | 252.9        | <b><u>&lt;0.001</u></b> | 319.6           | <b><u>&lt;0.001</u></b> | 308.2             | <b><u>&lt;0.001</u></b> | 206.3                | <b><u>&lt;0.001</u></b> |
| Pop  | 2  | 17.5         | <b><u>&lt;0.001</u></b> | 5.9             | 0.0518                  | 51.8              | <b><u>&lt;0.001</u></b> | 10.9                 | <b>0.0042</b>           |
| Cross type                                 | 4  | 113.8        | <b><u>&lt;0.001</u></b> | 91.9            | <b><u>&lt;0.001</u></b> | 41.9              | <b><u>&lt;0.001</u></b> | 66.3                 | <b><u>&lt;0.001</u></b> |
| Year                                       | 1  | 3.9          | <b>0.0494</b>           | 652.4           | <b><u>&lt;0.001</u></b> | 332.6             | <b><u>&lt;0.001</u></b> | 177.1                | <b><u>&lt;0.001</u></b> |
| Dam <sub>pop</sub>                         | 18 | 20.0         | 0.3330                  | 29.3            | <b>0.0454</b>           | 28.2              | 0.0590                  | 50.3                 | <b><u>&lt;0.001</u></b> |
| Sire <sub>pop</sub>                        | 83 | 133.8        | <b><u>&lt;0.001</u></b> | 136.5           | <b><u>&lt;0.001</u></b> | 115.4             | <b>0.0109</b>           | 99.7                 | 0.1860                  |
| Treatment x Soil                           | 2  | 37.0         | <b><u>&lt;0.001</u></b> | 24.3            | <b><u>&lt;0.001</u></b> | 35.4              | <b><u>&lt;0.001</u></b> | 21.6                 | <b><u>&lt;0.001</u></b> |
| Treatment x Pop                            | 4  | 6.4          | 0.1688                  | 1.3             | 0.8571                  | 7.8               | 0.0989                  | 1.1                  | 0.8988                  |
| Treatment x Cross type                     | 8  | 16.6         | <b>0.0342</b>           | 11.8            | 0.1620                  | 4.2               | 0.8352                  | 7.8                  | 0.4558                  |
| Treatment x Year                           | 2  | 21.1         | <b><u>&lt;0.001</u></b> | 16.4            | <b><u>&lt;0.001</u></b> | 10.6              | <b>0.0049</b>           | 14.8                 | <b><u>&lt;0.001</u></b> |
| Soil x Pop                                 | 2  | 2.5          | 0.2816                  | 0.5             | 0.7969                  | 0.8               | 0.6657                  | 1.0                  | 0.6014                  |
| Soil x Cross type                          | 4  | 9.5          | <b>0.0492</b>           | 12.9            | <b>0.0120</b>           | 10.7              | <b>0.0296</b>           | 0.3                  | 0.9883                  |
| Soil x Year                                | 1  | 404.7        | <b><u>&lt;0.001</u></b> | 390.2           | <b><u>&lt;0.001</u></b> | 516.2             | <b><u>&lt;0.001</u></b> | 408.8                | <b><u>&lt;0.001</u></b> |
| Pop x Cross type                           | 5  | 1.2          | 0.2674                  | 0.2             | 0.6885                  | 0.0               | 0.9923                  | 0.7                  | 0.3902                  |
| Pop x Year                                 | 2  | 113.1        | <b><u>&lt;0.001</u></b> | 58.3            | <b><u>&lt;0.001</u></b> | 83.6              | <b><u>&lt;0.001</u></b> | 46.6                 | <b><u>&lt;0.001</u></b> |
| Cross type x Year                          | 4  | 19.1         | <b><u>&lt;0.001</u></b> | 6.1             | 0.1886                  | 22.8              | <b><u>&lt;0.001</u></b> | 17.4                 | <b>0.0016</b>           |
| Treatment x Soil x Pop                     | 4  | 3.3          | 0.5085                  | 6.3             | 0.1750                  | 3.8               | 0.4267                  | 5.1                  | 0.2782                  |
| Treatment x Soil x Cross type              | 8  | 8.8          | 0.3619                  | 5.0             | 0.7575                  | 6.1               | 0.6380                  | 8.5                  | 0.3834                  |
| Treatment x Soil x Year                    | 2  | 5.0          | 0.0804                  | 1.8             | 0.4114                  | 3.3               | 0.1967                  | 8.2                  | <b>0.0162</b>           |
| Treatment x Pop x Cross type               | 9  | 6.1          | 0.7291                  | 15.1            | 0.0881                  | 13.7              | 0.1317                  | 15.5                 | 0.0783                  |
| Treatment x Pop x Year                     | 4  | 9.9          | <b>0.0415</b>           | 8.7             | 0.0691                  | 7.2               | 0.1274                  | 15.2                 | <b>0.0043</b>           |
| Treatment x Cross type x Year              | 8  | 7.9          | 0.4403                  | 11.8            | 0.1610                  | 17.8              | <b>0.0226</b>           | 28.9                 | <b><u>&lt;0.001</u></b> |
| Soil x Pop x Cross type                    | 5  | 2.3          | 0.8134                  | 4.8             | 0.4442                  | 3.2               | 0.6638                  | 3.1                  | 0.6836                  |
| Soil x Pop x Year                          | 2  | 15.9         | <b><u>&lt;0.001</u></b> | 6.3             | <b>0.0429</b>           | 3.2               | 0.1996                  | 1.6                  | 0.4428                  |
| Soil x Cross type x Year                   | 4  | 14.2         | <b>0.0066</b>           | 11.2            | <b>0.0243</b>           | 13.8              | <b>0.0079</b>           | 3.3                  | 0.5020                  |
| Pop x Cross type x Year                    | 5  | 35.3         | <b><u>&lt;0.001</u></b> | 30.9            | <b><u>&lt;0.001</u></b> | 31.6              | <b><u>&lt;0.001</u></b> | 8.7                  | 0.1195                  |
| Treatment x Soil x Pop x Cross type        | 7  | 6.6          | 0.4685                  | 5.9             | 0.5559                  | 3.6               | 0.8251                  | 11.6                 | 0.0728                  |
| Treatment x Soil x Pop x Year              | 4  | 1.3          | 0.8674                  | 5.5             | 0.2404                  | 15.6              | <b>0.0035</b>           | 12.9                 | <b>0.0117</b>           |
| Treatment x Soil x Cross type x Year       | 8  | 12.6         | 0.1260                  | 4.3             | 0.8271                  | 7.3               | 0.5026                  | 14.9                 | <b>0.0374</b>           |
| Treatment x Pop x Cross type x Year        | 9  | 6.5          | 0.6875                  | 6.6             | 0.6738                  | 9.8               | 0.3695                  | 16.9                 | <b>0.0183</b>           |
| Soil x Pop x Cross type x Year             | 5  | 7.0          | 0.2242                  | 5.9             | 0.3148                  | 11.6              | <b>0.0415</b>           | 21.3                 | <b><u>&lt;0.001</u></b> |
| Treatment x Soil x Pop x Cross type x Year | 6  | 6.2          | 0.4051                  | 7.9             | 0.2482                  | 10.1              | 0.0735                  | 15.5                 | <b><u>0.0015</u></b>    |

Electronic Appendix 3. – Inbreeding/outbreeding depression (A) and change in log fitness  $\pm$  standard error (B) for early and mid-cycle traits. For germination, estimates per soil type (garden or serpentine) are only reported when a significant interaction cross type x soil was detected. The results of significance testing made for the inbreeding and outbreeding load are reported: grey – non significant, black – significant effect of cross type or an interaction in the linear regression according to  $\chi^2$  testing of log-likelihood ratios, bold and underlined – significant according to a t-test comparison to the within population outcrossed offspring.

A)

|                    |            | Z1              |             |             | Z2           |                 |             |             | Z6           |                 |             |             |
|--------------------|------------|-----------------|-------------|-------------|--------------|-----------------|-------------|-------------|--------------|-----------------|-------------|-------------|
|                    |            | Seed production | Seed number | Germination | Pollen donor | Seed production | Seed number | Germination | Pollen donor | Seed production | Seed number | Germination |
| <u>Inbreeding</u>  |            |                 |             |             |              |                 |             |             |              |                 |             |             |
| Soil type          | Garden     | -0.125          | -0.337      | -           |              | 0.104           | 0.151       | 0.142       |              | 0.009           | 0.407       | 0.319       |
|                    | Serpentine |                 |             | -0.017      |              |                 |             |             |              |                 |             |             |
| <u>Outbreeding</u> |            |                 |             |             |              |                 |             |             |              |                 |             |             |
| Pollen donor       | Z6         | 0.089           | 0.245       | 0.084       | Z6           | -0.026          | 0.005       | 0.080       | Z1           | 0.067           | -0.304      | -0.056      |
|                    | Z2         | 0.073           | 0.083       | 0.076       | Z1           | -0.028          | -0.075      | 0.008       | Z2           | 0.157           | 0.205       | 0.042       |

B)

|                             |  | Z1                |   |                   | Z2                 |                    |                    | Z6                 |                    |                    |                   |                   |
|-----------------------------|--|-------------------|---|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|
|                             |  | Seed production   | Seed number                                 | Germination       | Seed production    | Seed number        | Germination        | Seed production    | Seed number        | Germination        |                   |                   |
| <u>Inbreeding</u>           |  |                   |   |                   |                    |                    |                    |                    |                    |                    |                   |                   |
|                             |  | 0.050 $\pm$ 0.120 | 0.329 $\pm$ 0.420                           |                   | -0.203 $\pm$ 0.161 | -0.290 $\pm$ 0.475 | -0.047 $\pm$ 0.055 | 0.002 $\pm$ 0.136  | -0.482 $\pm$ 0.506 | -0.236 $\pm$ 0.128 |                   |                   |
| Ctrl                        |  |                   | 0.065 $\pm$ 0.055                           |                   |                    |                    |                    |                    |                    |                    |                   |                   |
| Serp                        |  |                   | <b><u>-0.118 <math>\pm</math> 0.058</u></b> |                   |                    |                    |                    |                    |                    |                    |                   |                   |
| <u>Between pop breeding</u> |  |                   |   |                   |                    |                    |                    |                    |                    |                    |                   |                   |
| Z6                          |  | 0.027 $\pm$ 0.519 | 0.184 $\pm$ 0.769                           | 0.032 $\pm$ 0.056 | Z6                 | 0.169 $\pm$ 0.514  | 0.580 $\pm$ 0.901  | -0.008 $\pm$ 0.058 | Z1                 | -0.326 $\pm$ 0.415 | 1.558 $\pm$ 0.974 | 0.006 $\pm$ 0.115 |
| Z2                          |  | 0.612 $\pm$ 0.591 | 0.919 $\pm$ 0.895                           | 0.071 $\pm$ 0.051 | Z1                 | 0.147 $\pm$ 0.601  | -0.245 $\pm$ 1.282 | -0.044 $\pm$ 0.053 | Z2                 | -0.381 $\pm$ 0.540 | 0.067 $\pm$ 0.732 | 0.070 $\pm$ 0.108 |

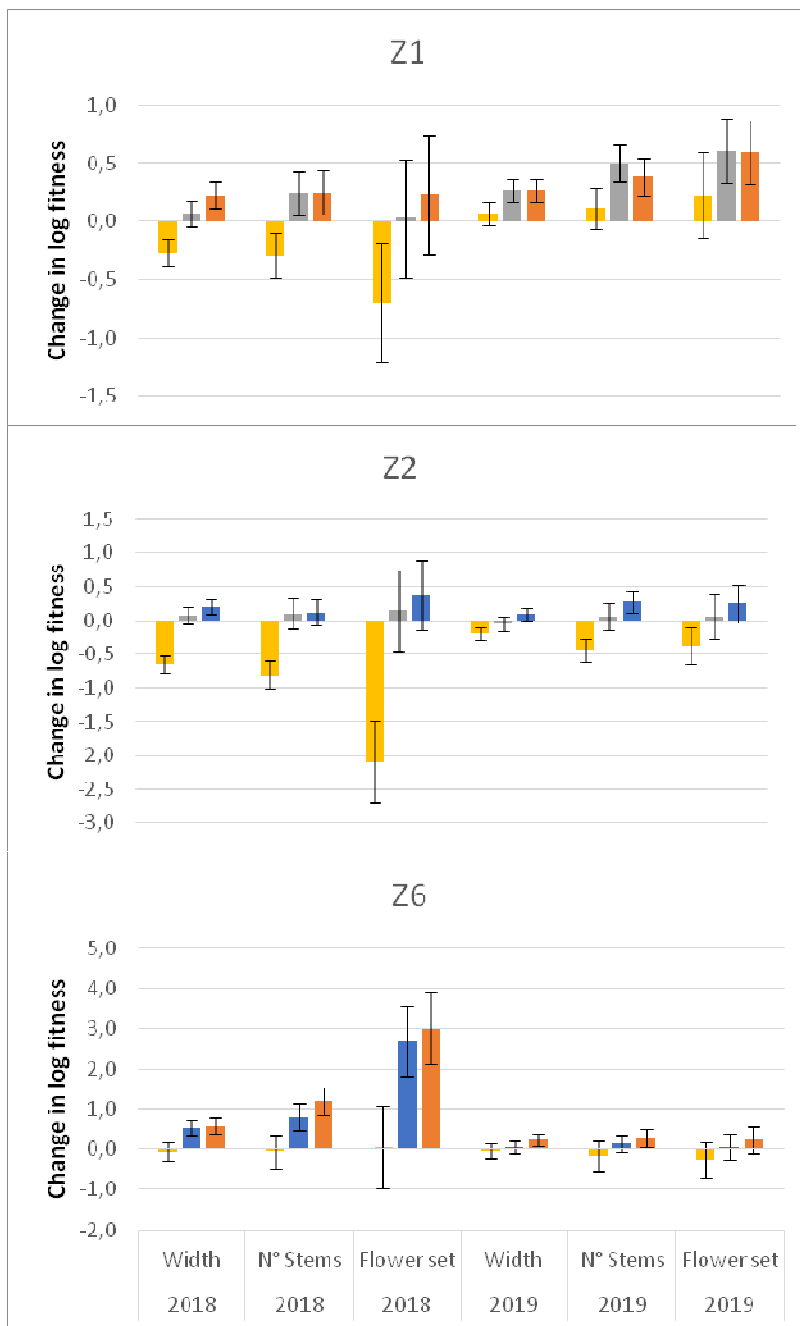
Electronic Appendix 4. – (A) Inbreeding/outbreeding depression estimates and (B) change in log fitness in late-acting traits ( $\pm$  standard error). A negative value signifies a decrease of performance in between population relative to within population outbred offspring. Estimates per soil type (garden or serpentine), treatment (control, competition, shade) or soil x treatment, are only reported when a significant interaction with cross type was detected. The results of significance testing made for the inbreeding and outbreeding load are reported: grey – non significant (without further testing per soil or treatment), black – significant effect of cross type or an interaction with cross type in the linear regression according to  $\chi^2$  testing of log-likelihood ratios, bold – significant according to a t-test comparison to the within population outcrossed offspring.

A)

|             | Treatment + cross | Z1                       |              |              | Z2     |               |                          | Z6           |               |              |             |                          |               |               |               |        |        |
|-------------|-------------------|--------------------------|--------------|--------------|--------|---------------|--------------------------|--------------|---------------|--------------|-------------|--------------------------|---------------|---------------|---------------|--------|--------|
|             |                   | Width                    | Stem number  | Flower set   | Width  | Stem number   | Flower set               | Width        | Stem number   | Flower set   |             |                          |               |               |               |        |        |
| Inbreeding  | 2018              | Global                   | <b>0.066</b> | 0.126        | 0.114  | Global        | Z6                       | -            | -             | -            | Global      | Z1                       | -0.368        | <b>-0.388</b> | <b>-0.647</b> |        |        |
|             |                   | Control                  |              |              |        |               | Z1                       | -            | -             | -            |             | Z2                       | <b>-0.331</b> | <b>-0.28</b>  | <b>-0.692</b> |        |        |
|             |                   | Competition              |              |              |        |               | Garden                   | Z6           | -0.059        | -0.142       |             | -0.039                   | Control       | Z6            |               |        |        |
|             |                   | Shade                    |              |              |        |               |                          | Z1           | <b>-0.144</b> | -0.042       |             | -0.112                   |               | Z2            |               |        |        |
|             | 2019              | Global                   | 0.084        | -            | -      | Serpentine    | Z6                       | <b>0.355</b> | 0.170         | <b>0.601</b> | Competition | Z6                       |               |               |               |        |        |
|             |                   | Control                  |              | 0.021        | -0.009 |               | Z1                       | <b>0.262</b> | <b>0.048</b>  | 0.210        |             | Z2                       |               |               |               |        |        |
|             |                   | Competition              |              | <b>0.358</b> | 0.363  |               |                          |              |               |              |             | Shade                    | Z6            |               |               |        |        |
|             |                   | Shade                    |              | -0.390       | -0.82  |               |                          |              |               |              |             |                          | Z2            |               |               |        |        |
| Outbreeding | 2018              | Global                   | Z6           | -0.247       | -0.311 | -             | Global                   | Z6           | -0.099        | -0.199       | -0.212      | Global                   | Z1            | -0.081        | 0.055         | -      |        |
|             |                   |                          | Z2           | -0.205       | -0.215 | -             |                          | Z1           | -0.076        | -0.16        | -0.107      |                          | Z2            | -0.055        | 0.069         | -      |        |
|             |                   | Control                  | Z6           |              |        | <b>-0.351</b> | Control - Garden         | Z1           |               |              |             |                          |               |               |               | -0.167 |        |
|             |                   |                          | Z2           |              |        | <b>-0.383</b> |                          | Z2           |               |              |             |                          |               |               |               | 0.033  |        |
|             |                   | Competition              | Z6           |              |        | <b>-0.282</b> | Competition - Garden     | Z1           |               |              |             |                          |               |               |               | 0.163  |        |
|             |                   |                          | Z2           |              |        | <b>-0.167</b> |                          | Z2           |               |              |             |                          |               |               |               | 0.139  |        |
|             |                   | Shade                    | Z6           |              |        | <b>-0.851</b> | Shade - Garden           | Z1           |               |              |             |                          |               |               |               | -      |        |
|             |                   |                          | Z2           |              |        | -0.802        |                          | Z2           |               |              |             |                          |               |               |               |        | -0.68  |
|             | 2019              | Control - Serpentine     | Z1           |              |        |               | Control - Serpentine     | Z1           |               |              |             | Control - Serpentine     | Z1            |               |               | -0.088 |        |
|             |                   |                          | Z2           |              |        |               |                          | Z2           |               |              |             |                          | Z2            |               |               |        | -0.29  |
|             |                   | Competition - Serpentine | Z1           |              |        |               | Competition - Serpentine | Z1           |               |              |             | Competition - Serpentine | Z1            |               |               | -0.161 |        |
|             |                   |                          | Z2           |              |        |               |                          | Z2           |               |              |             |                          | Z2            |               |               |        | -0.751 |
|             |                   | Shade - Serpentine       | Z1           |              |        |               | Shade - Serpentine       | Z1           |               |              |             | Shade - Serpentine       | Z1            |               |               | -0.186 |        |
|             |                   |                          | Z2           |              |        |               |                          | Z2           |               |              |             |                          | Z2            |               |               |        |        |

B)

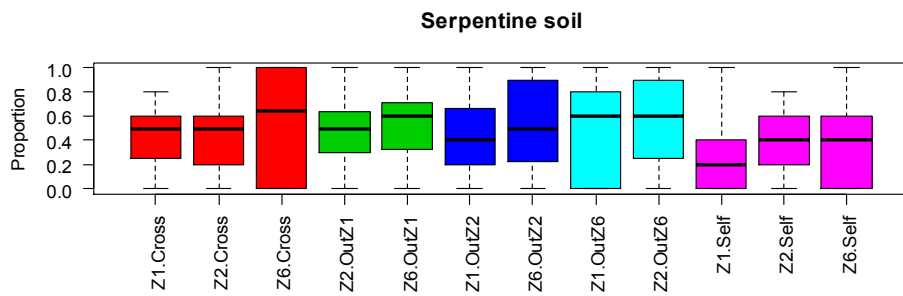
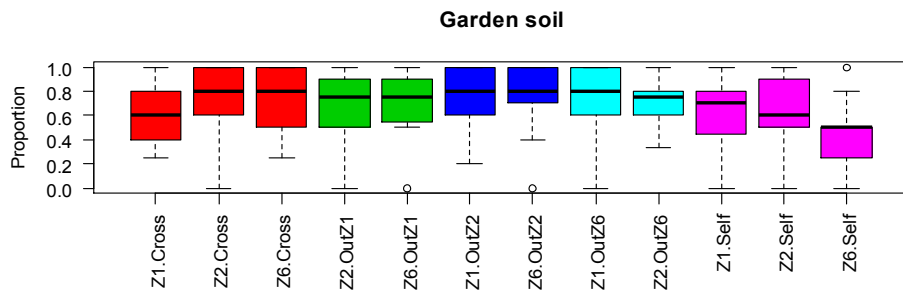
|                   |       | Z1          |                       |                      |                       | Z2                   |                       |                       |                       | Z6                    |                          |                      |                      |                      |                      |               |
|-------------------|-------|-------------|-----------------------|----------------------|-----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------------------|----------------------|----------------------|----------------------|----------------------|---------------|
| Treatment + cross |       | Width       | N° Stems              | Flower set           | Treatment + cross     | Width                | N° Stems              | Flower set            | Treatment + cross     | Width                 | N° Stems                 | Flower set           |                      |                      |                      |               |
| Inbreeding        | 2018  | Global      | -0.292 ± 0.216        | -0.698 ± 0.524       | <b>-0.65 ± 0.124</b>  | Global               | <b>-0.65 ± 0.124</b>  | -                     | <b>-2.093 ± 0.606</b> | Global                | -0.061 ± 0.244           | -0.052 ± 0.41        | 0.045 ± 1.028        |                      |                      |               |
|                   |       | Control     |                       |                      |                       |                      |                       | <b>-2.004 ± 0.665</b> |                       |                       |                          |                      |                      |                      |                      |               |
|                   |       | Competition |                       |                      |                       |                      |                       | <b>-1.65 ± 0.603</b>  |                       |                       |                          |                      |                      |                      |                      |               |
|                   |       | Shade       |                       |                      |                       |                      |                       | <b>-3.12 ± 1.248</b>  |                       |                       |                          |                      |                      |                      |                      |               |
|                   | 2019  | Global      | -                     | -                    | -                     | Global               |                       | <b>-0.438 ± 0.177</b> | -0.378 ± 0.271        | Global                | -0.047 ± 0.198           | -0.168 ± 0.364       | -0.257 ± 0.44        |                      |                      |               |
|                   |       | Control     | 0.076 ± 0.146         | 0.182 ± 0.192        | <b>-0.187 ± 0.068</b> |                      | <b>-0.187 ± 0.068</b> |                       |                       |                       |                          |                      |                      |                      |                      |               |
|                   |       | Competition | <b>-0.532 ± 0.198</b> | -0.566 ± 0.4         | 0.04 ± 0.108          |                      | 0.04 ± 0.108          |                       |                       |                       |                          |                      |                      |                      |                      |               |
|                   |       | Shade       | 0.552 ± 0.313         | 1.927 ± 1.011        | 0.589 ± 0.455         |                      | 0.589 ± 0.455         | -                     | -                     |                       |                          |                      |                      |                      |                      |               |
| Outbreeding       | 2018  | Global      | Z6                    | -                    | 0.238 ± 0.188         | -                    | Global                | Z6                    | -                     | -                     | -                        | Global               | <b>0.59 ± 0.202</b>  | <b>1.203 ± 0.338</b> | <b>3.009 ± 0.888</b> |               |
|                   |       |             | Z2                    | -                    | 0.244 ± 0.188         | -                    | Z1                    | -                     | -                     | -                     | <b>0.539 ± 0.193</b>     | <b>0.799 ± 0.323</b> | <b>2.686 ± 0.863</b> |                      |                      |               |
|                   |       | Control     | Z6                    | 0.055 ± 0.122        |                       | -0.067 ± 0.53        | Control               | Z6                    | 0.092 ± 0.097         | 0.159 ± 0.178         | 0.319 ± 0.411            |                      |                      |                      |                      |               |
|                   |       |             | Z2                    | 0.201 ± 0.119        |                       | 0.124 ± 0.513        | Z1                    | <b>0.219 ± 0.086</b>  | 0.141 ± 0.158         | 0.471 ± 0.363         |                          |                      |                      |                      |                      |               |
|                   |       | Competition | Z6                    | 0.194 ± 0.119        |                       | 0.239 ± 0.546        | Serpentine            | Z6                    | <b>-0.476 ± 0.173</b> | -0.566 ± 0.299        | <b>-2.353 ± 0.884</b>    |                      |                      |                      |                      |               |
|                   |       |             | Z2                    | 0.116 ± 0.119        |                       | 0.248 ± 0.546        |                       | Z1                    | <b>-0.323 ± 0.157</b> | <b>-0.591 ± 0.272</b> | -1.562 ± 0.803           |                      |                      |                      |                      |               |
|                   | Shade | Z6          | -0.138 ± 0.158        |                      | <b>-1.385 ± 0.677</b> | Z6                   |                       |                       |                       |                       |                          |                      |                      |                      |                      |               |
|                   |       | Z2          | 0.027 ± 0.152         |                      | 0.12 ± 0.651          | Z1                   |                       |                       |                       |                       |                          |                      |                      |                      |                      |               |
|                   | 2019  | Global      | Z6                    | <b>0.262 ± 0.097</b> | <b>0.501 ± 0.157</b>  | -                    | Global                | Z6                    | -0.057 ± 0.105        | 0.065 ± 0.199         | 0.062 ± 0.33             | Global               | Z1                   | 0.238 ± 0.151        | 0.275 ± 0.228        | -             |
|                   |       |             | Z2                    | <b>0.264 ± 0.097</b> | <b>0.382 ± 0.156</b>  | -                    |                       | Z1                    | 0.088 ± 0.088         | 0.273 ± 0.167         | 0.248 ± 0.277            |                      | Z2                   | 0.049 ± 0.145        | 0.143 ± 0.219        | -             |
|                   |       | Control     | Z6                    |                      |                       | <b>0.592 ± 0.163</b> |                       |                       |                       |                       |                          | Control - Control    | Z1                   |                      |                      | 0.289 ± 0.218 |
|                   |       |             | Z2                    |                      |                       | <b>0.624 ± 0.158</b> |                       |                       |                       |                       |                          | Z2                   |                      |                      | 0.104 ± 0.21         |               |
| Competition       |       | Z6          |                       |                      | <b>0.709 ± 0.278</b>  |                      |                       |                       |                       |                       | Competition - Control    | Z1                   |                      |                      | -0.056 ± 0.239       |               |
|                   |       | Z2          |                       |                      | <b>0.602 ± 0.278</b>  |                      |                       |                       |                       |                       | Z2                       |                      |                      | -0.187 ± 0.23        |                      |               |
| Shade             |       | Z6          |                       |                      | <b>2.311 ± 0.745</b>  |                      |                       |                       |                       |                       | Shade - Control          | Z2                   |                      |                      |                      |               |
|                   |       | Z2          |                       |                      | 0.797 ± 0.723         |                      |                       |                       |                       |                       | Z1                       |                      |                      |                      |                      |               |
|                   |       |             |                       |                      |                       |                      |                       |                       |                       |                       | Ctrl. - Serp.            | Z2                   |                      |                      | 0.051 ± 0.258        |               |
|                   |       |             |                       |                      |                       |                      |                       |                       |                       |                       | Competition - Serpentine | Z1                   |                      |                      | 0.389 ± 0.292        |               |
|                   |       |             |                       |                      |                       |                      |                       |                       |                       | Z2                    |                          |                      | 0.291 ± 0.279        |                      |                      |               |
|                   |       |             |                       |                      |                       |                      |                       |                       |                       | Shade - Serpentine    | Z1                       |                      |                      | 0.394 ± 1.846        |                      |               |
|                   |       |             |                       |                      |                       |                      |                       |                       |                       | Z2                    |                          |                      | -0.926 ± 1.692       |                      |                      |               |



Electronic Appendix 5. – Change in log fitness for late life cycle traits. The bars correspond to the performance of inbred or between population outbred offspring relative to that of the within population outbred offspring (set at 0). Yellow – inbred, blue – outbred with Z1 as pollen donor, orange – outbred with Z2, grey – outbred with Z6. Note the inversion of the y-axis, so that values below the axis indicate inbreeding/outbreeding depression, and values above inbreeding benefit or heterosis. Error bars correspond to standard errors. Note the difference in scales on the y-axes.

Electronic Appendix 6. – Analyses of early and mid-cycle traits. Significant values are in bold. Dam – pollen recipient (nested in population), Sire – pollen donor (nested in population).

|                         | Pollination success (1077) |          |              | Seed number (605) |          |              | Germination (511) |          |                   |
|-------------------------|----------------------------|----------|--------------|-------------------|----------|--------------|-------------------|----------|-------------------|
|                         | Df                         | Deviance | p-value      | Df                | Deviance | p-value      | Df                | Deviance | p-value           |
| Soil                    | -                          | -        | -            | -                 | -        | -            | 1                 | 3.636    | <b>&lt; 0.001</b> |
| Cross type              | 4                          | 0.449    | 0.752        | 4                 | 1.501    | 0.546        | 4                 | 0.843    | <b>&lt; 0.001</b> |
| Pop                     | 2                          | 0.021    | 0.957        | 2                 | 0.532    | 0.580        | 2                 | 0.105    | 0.253             |
| Soil x cross type       | -                          | -        | -            | -                 | -        | -            | 4                 | 0.177    | 0.325             |
| Soil x pop              | -                          | -        | -            | -                 | -        | -            | 2                 | 0.111    | 0.233             |
| Cross type x Pop        | 5                          | 1.541    | 0.255        | 5                 | 6.244    | <b>0.026</b> | 5                 | 0.042    | 0.953             |
| Soil x Cross type x Pop | -                          | -        | -            | -                 | -        | -            | 5                 | 0.195    | 0.401             |
| Dam <sub>Pop</sub>      | 26                         | 9.938    | <b>0.023</b> | 26                | 20.91    | <b>0.020</b> | 27                | 1.709    | <b>0.017</b>      |
| Sire <sub>Pop</sub>     | 238                        | 50.963   | 0.831        | 185               | 75.913   | 0.945        | -                 | -        | -                 |



Electronic Appendix 7. – Germination by cross type and population in garden and serpentine soil. Colour code corresponds to the pollination type – red – outcrossing within population, green –outcrossing with population Z1, blue – outcrossing with population Z2, teal – outcrossing with population Z6, magenta – selfing.



Electronic Appendix 8. – Analyses of inbreeding and outbreeding depression for early and mid-cycle traits. Inbreeding depression analyses were done on a data subset that only included within-population inbred and outbred offspring, with the latter set as the intercept of the regression. Outbreeding depression analyses were done on a data subset that only included within- and between-population outbred offspring, with the former set as the intercept of the regression. Significant are in bold. Dam – pollen recipient (nested in population), Sire – pollen donor (nested in population). Sample sizes for each regression are given in brackets on the top of the Df column.

|                        |                            | Z6                         |          |              | Z1    |          |                   | Z2    |          |                   |
|------------------------|----------------------------|----------------------------|----------|--------------|-------|----------|-------------------|-------|----------|-------------------|
|                        |                            | Df                         | Deviance | p-value      | Df    | Deviance | p-value           | Df    | Deviance | p-value           |
| <u>Inbreeding</u>      | <u>Pollination success</u> | (119)                      |          |              | (381) |          |                   | (288) |          |                   |
|                        | Cross type                 | 1                          | 0.031    | 0.709        | 1     | 0.561    | 0.115             | 1     | 0.631    | 0.106             |
|                        | Dam <sub>pop</sub>         | 4                          | 1.554    | 0.143        | 9     | 0.945    | 0.900             | 11    | 2.764    | 0.405             |
|                        | Sire <sub>pop</sub>        | 7                          | 2.378    | 0.161        | 40    | 6.991    | 0.850             | 52    | 11.78    | 0.597             |
|                        | <u>Seed production</u>     | (63)                       |          |              | (210) |          |                   | (168) |          |                   |
|                        | Cross type                 | 1                          | 3.415    | <b>0.028</b> | 1     | 1.211    | 0.264             | 1     | 1.535    | 0.162             |
|                        | Dam <sub>pop</sub>         | 4                          | 6.812    | <b>0.048</b> | 9     | 5.623    | 0.761             | 11    | 13.68    | 0.095             |
|                        | Sire <sub>pop</sub>        | 6                          | 0.854    | 0.977        | 32    | 22.20    | 0.883             | 37    | 22.65    | 0.826             |
|                        | <u>Germination</u>         | (63)                       |          |              | (175) |          |                   | (143) |          |                   |
|                        | Soil                       | 1                          | 0.061    | 0.287        | 1     | 1.304    | <b>&lt; 0.001</b> | 1     | 0.979    | <b>&lt; 0.001</b> |
|                        | Cross type                 | 1                          | 0.115    | 0.144        | 1     | 0.181    | <b>0.012</b>      | 1     | 0.081    | 0.133             |
|                        | Soil x Cross type          | 1                          | 0.004    | 0.791        | 1     | 0.198    | <b>0.009</b>      | 1     | 0.005    | 0.706             |
|                        | Dam(Pop)                   | 4                          | 0.401    | 0.115        | 11    | 0.612    | <b>0.031</b>      | 11    | 0.367    | 0.512             |
|                        | <u>Outbreeding</u>         | <u>Pollination success</u> | (71)     |              |       | (275)    |                   |       | (239)    |                   |
| Cross type             |                            | 2                          | 0.538    | 0.347        | 2     | 0.331    | 0.480             | 2     | 0.033    | 0.932             |
| Dam(Pop)               |                            | 4                          | 1.210    | 0.313        | 11    | 5.561    | <b>0.010</b>      | 11    | 3.667    | 0.157             |
| Sire(Pop)              |                            | 54                         | 15.127   | 0.281        | 94    | 16.828   | 0.931             | 86    | 19.401   | 0.585             |
| <u>Seed production</u> |                            | (39)                       |          |              | (146) |          |                   | (125) |          |                   |
| Cross type             |                            | 2                          | 2.456    | 0.148        | 2     | 1.783    | 0.314             | 2     | 1.665    | 0.386             |
| Dam <sub>pop</sub>     |                            | 4                          | 4.695    | 0.121        | 11    | 13.502   | 0.093             | 11    | 15.877   | 0.078             |
| Sire <sub>pop</sub>    |                            | 38                         | 17.328   | 0.909        | 70    | 66.824   | 0.085             | 65    | 47.488   | 0.824             |
| <u>Germination</u>     |                            | (29)                       |          |              | (109) |          |                   | (101) |          |                   |
| Soil                   |                            | 1                          | 0.235    | <b>0.027</b> | 1     | 1.243    | <b>&lt; 0.001</b> | 1     | 0.773    | <b>&lt; 0.001</b> |
| Cross type             |                            | 2                          | 0.020    | 0.816        | 2     | 0.013    | 0.828             | 2     | 0.028    | 0.668             |
| Soil x Cross type      |                            | 2                          | 0.002    | 0.978        | 2     | 0.052    | 0.479             | 2     | 0.096    | 0.257             |
| Dam <sub>pop</sub>     |                            | 4                          | 0.326    | 0.147        | 12    | 1.055    | <b>0.003</b>      | 11    | 0.507    | 0.214             |

Electronic Appendix 9. – Analyses of late cycle traits in each year separately. Significant values are in bold, significant values after correction for multiple comparisons in a model (16 in total) are underlined. Dam – pollen recipient (nested in population). Sample sizes are given in brackets next to the trait.

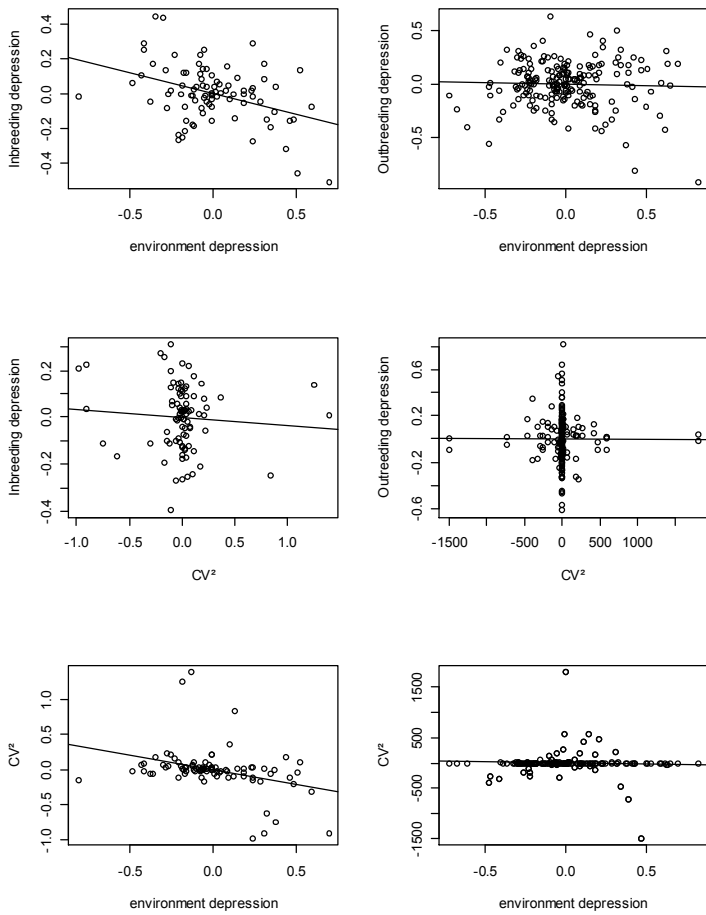
|                                     |    | 2018        |                  |                |                  |                  |                  |                     |                  | 2019                    |                  |             |                  |                |                  |                  |                  |
|-------------------------------------|----|-------------|------------------|----------------|------------------|------------------|------------------|---------------------|------------------|-------------------------|------------------|-------------|------------------|----------------|------------------|------------------|------------------|
| Variable                            | DF | Width (869) |                  | N° stems (869) |                  | Flower set (856) |                  | Flower number (646) |                  | Flower production (869) |                  | Width (809) |                  | N° stems (802) |                  | Flower set (796) |                  |
|                                     |    | Dev         | p-value          | Dev            | p-value          | Dev              | p-value          | Dev                 | p-value          | Dev                     | p-value          | Dev         | p-value          | Dev            | p-value          | Dev              | p-value          |
| Treatment                           | 2  | 71.0        | <u>&lt;0.001</u> | 16.9           | <u>&lt;0.001</u> | 90.7             | <u>&lt;0.001</u> | 73.7                | <u>&lt;0.001</u> | 21.1                    | <u>&lt;0.001</u> | 216.9       | <u>&lt;0.001</u> | 77.6           | <u>&lt;0.001</u> | 321.8            | <u>&lt;0.001</u> |
| Soil                                | 1  | 598.0       | <u>&lt;0.001</u> | 0.1            | 0.7790           | 637.5            | <u>&lt;0.001</u> | 594.4               | <u>&lt;0.001</u> | 227.0                   | <u>&lt;0.001</u> | 9.3         | <b>0.0023</b>    | 617.1          | <u>&lt;0.001</u> | 0.4              | 0.5377           |
| Pop                                 | 2  | 93.5        | <u>&lt;0.001</u> | 35.4           | <u>&lt;0.001</u> | 56.5             | <u>&lt;0.001</u> | 96.1                | <u>&lt;0.001</u> | 68.8                    | <u>&lt;0.001</u> | 21.7        | <u>&lt;0.001</u> | 123.1          | <u>&lt;0.001</u> | 3.4              | 0.1790           |
| Cross type                          | 4  | 112.1       | <u>&lt;0.001</u> | 85.6           | <u>&lt;0.001</u> | 63.0             | <u>&lt;0.001</u> | 94.9                | <u>&lt;0.001</u> | 15.2                    | <u>&lt;0.001</u> | 95.3        | <u>&lt;0.001</u> | 41.6           | <u>&lt;0.001</u> | 54.4             | <u>&lt;0.001</u> |
| Dam <sub>Pop</sub>                  | 21 | 52.3        | <u>&lt;0.001</u> | 42.1           | <b>0.0041</b>    | 44.1             | <b>0.0023</b>    | 52.8                | <u>&lt;0.001</u> | 55.0                    | <u>&lt;0.001</u> | 48.8        | <u>&lt;0.001</u> | 65.7           | <u>&lt;0.001</u> | 31.0             | 0.0736           |
| Treatment x Soil                    | 2  | 12.0        | <u>&lt;0.001</u> | 45.3           | <u>&lt;0.001</u> | 5.7              | 0.0590           | 5.7                 | 0.0589           | 5.9                     | 0.0514           | 29.9        | <u>&lt;0.001</u> | 12.1           | <b>0.0024</b>    | 77.9             | <u>&lt;0.001</u> |
| Treatment x Pop                     | 4  | 3.0         | 0.5639           | 24.2           | <u>&lt;0.001</u> | 2.3              | 0.6810           | 2.0                 | 0.7333           | 3.0                     | 0.5529           | 7.5         | 0.1121           | 12.9           | <b>0.0116</b>    | 10.7             | <b>0.0305</b>    |
| Treatment x Cross type              | 8  | 11.5        | 0.1731           | 12.8           | 0.1173           | 9.8              | 0.2790           | 9.2                 | 0.3268           | 4.9                     | 0.7694           | 14.9        | 0.0611           | 12.9           | 0.1165           | 22.4             | <b>0.0043</b>    |
| Soil x Pop                          | 2  | 3.1         | 0.2105           | 34.8           | <u>&lt;0.001</u> | 1.7              | 0.4346           | 2.4                 | 0.3034           | 2.0                     | 0.3726           | 9.6         | <b>0.0081</b>    | 0.9            | 0.6233           | 4.9              | 0.0871           |
| Soil x Cross type                   | 4  | 17.1        | <b>0.0019</b>    | 3.1            | 0.5491           | 13.5             | <b>0.0093</b>    | 18.8                | <u>&lt;0.001</u> | 7.3                     | 0.1213           | 2.4         | 0.6549           | 15.7           | <b>0.0035</b>    | 3.6              | 0.4630           |
| Pop x Cross type                    | 5  | 44.4        | <u>&lt;0.001</u> | 6.5            | 0.2637           | 31.6             | <u>&lt;0.001</u> | 42.8                | <u>&lt;0.001</u> | 28.9                    | <u>&lt;0.001</u> | 7.2         | 0.2079           | 40.8           | <u>&lt;0.001</u> | 7.6              | 0.1770           |
| Treatment x Soil x Pop              | 4  | 1.7         | 0.7928           | 7.6            | 0.1065           | 2.3              | 0.6812           | 1.5                 | 0.8319           | 4.6                     | 0.3300           | 17.3        | <b>0.0017</b>    | 12.0           | <b>0.0172</b>    | 23.6             | <u>&lt;0.001</u> |
| Treatment x Soil x Cross type       | 8  | 8.9         | 0.3518           | 16.9           | <b>0.0310</b>    | 8.6              | 0.3789           | 4.3                 | 0.8252           | 8.3                     | 0.4051           | 4.0         | 0.8608           | 9.0            | 0.3445           | 4.6              | 0.7975           |
| Treatment x Pop x Cross type        | 9  | 9.4         | 0.3987           | 10.7           | 0.2962           | 15.2             | 0.0844           | 7.9                 | 0.5474           | 14.6                    | 0.1010           | 10.7        | 0.2969           | 12.2           | 0.2015           | 10.1             | 0.3389           |
| Soil x Pop x Cross type             | 5  | 6.3         | 0.2750           | 4.7            | 0.4576           | 4.3              | 0.5031           | 6.9                 | 0.2277           | 6.4                     | 0.2670           | 4.4         | 0.4974           | 12.9           | <b>0.0239</b>    | 7.4              | 0.1956           |
| Treatment x Soil x Pop x Cross type | 7  | 4.4         | 0.7298           | 8.7            | 0.2726           | 5.6              | 0.5878           | 3.8                 | 0.8030           | -                       | -                | 12.1        | 0.0986           | 3.9            | 0.7925           | 16.5             | <b>0.0211</b>    |

Electronic Appendix 10. – Analyses of inbreeding and outbreeding depression for late cycle traits. Inbreeding depression analyses were done on a data subset that only included within-population inbred and outbred offspring, with the latter set as the intercept of the regression. Outbreeding depression analyses were done on a data subset that only included within- and between-population outbred offspring, with the former set as the intercept of the regression. Significant values are in bold, significant values after correction for multiple comparisons (30 in total) are underlined. Dam – pollen recipient (nested in population). Sample sizes for each regression are given in brackets on the top of the p-value column.

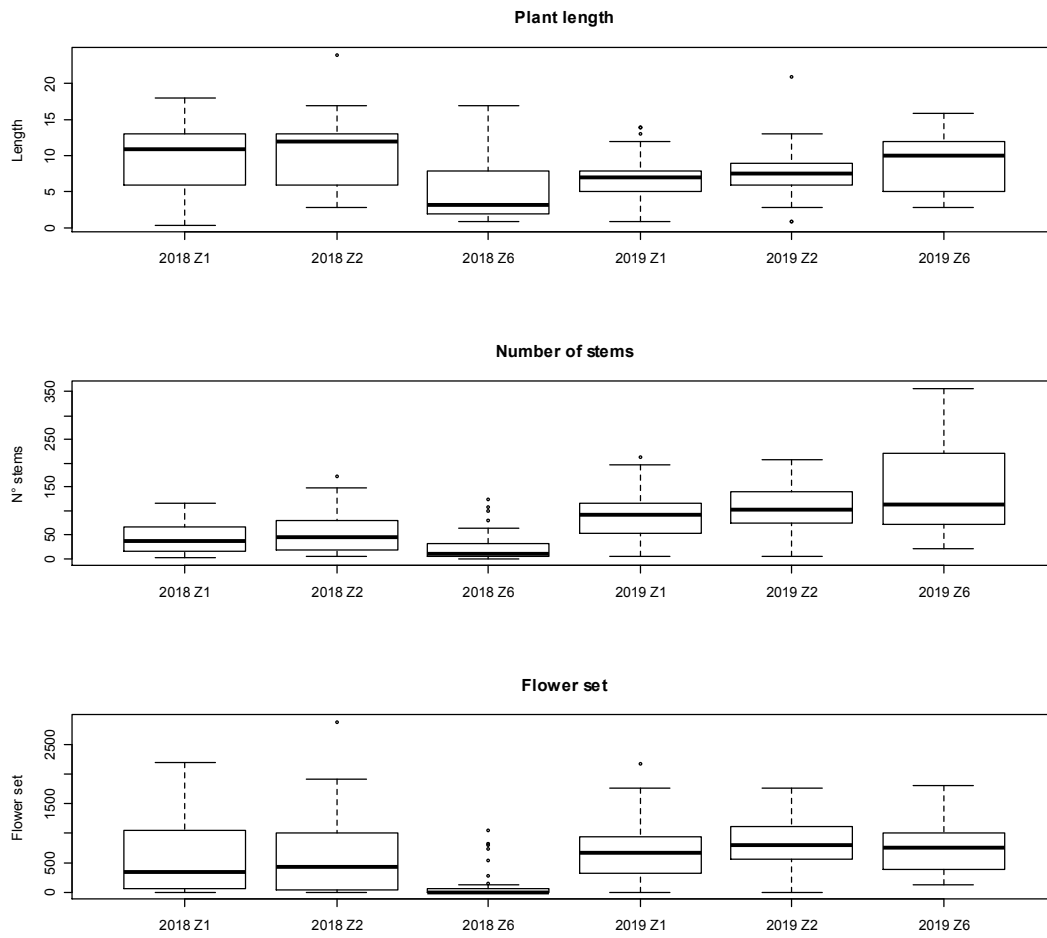
|                               |                               | Z6                     |       |              |                  |              |                  |              |                  | Z1           |                  |                  |              |                  |                  |                  |              | Z2           |                  |         |                  |              |                  |  |  |
|-------------------------------|-------------------------------|------------------------|-------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|------------------|------------------|--------------|------------------|------------------|------------------|--------------|--------------|------------------|---------|------------------|--------------|------------------|--|--|
| INBREEDING                    |                               | DF                     | Width | N° stems     |                  | Flower set   |                  | DF           | Width            | N° stems     |                  | Flower set       |              | DF               | Width            | N° stems         |              | Flower set   |                  |         |                  |              |                  |  |  |
|                               |                               |                        | Dev   | p-value      | Dev              | p-value      | Dev              | p-value      | Dev              | p-value      | Dev              | p-value          | Dev          | p-value          | Dev              | p-value          | Dev          | p-value      | Dev              | p-value |                  |              |                  |  |  |
| Inbreeding                    | 2018                          | (Sample size)          |       | (67)         | (67)             | (66)         | (183)            | (183)        | (180)            |              |                  |                  |              |                  |                  |                  |              |              |                  |         |                  |              |                  |  |  |
|                               |                               | Treatment              | 2     | 0.2          | 0.905            | 0.9          | 0.628            | 0.4          | 0.826            | 2            | 23.7             | <u>&lt;0.001</u> | 25.5         | <u>&lt;0.001</u> | 31.7             | <u>&lt;0.001</u> | 2            | 1.4          | 0.488            | 4.5     | 0.104            | 4.3          | 0.118            |  |  |
|                               |                               | Soil                   | 1     | 35.1         | <u>&lt;0.001</u> | 38.2         | <u>&lt;0.001</u> | 32.2         | <u>&lt;0.001</u> | 1            | 133.0            | <u>&lt;0.001</u> | 120.5        | <u>&lt;0.001</u> | 136.8            | <u>&lt;0.001</u> | 1            | 68.2         | <u>&lt;0.001</u> | 93.3    | <u>&lt;0.001</u> | 78.7         | <u>&lt;0.001</u> |  |  |
|                               |                               | Cross type             | 1     | 0.3          | 0.603            | 2.2          | 0.135            | 1.0          | 0.320            | 1            | 6.8              | <b>0.009</b>     | 7.4          | <b>0.007</b>     | 1.2              | 0.265            | 1            | 56.9         | <u>&lt;0.001</u> | 30.2    | <u>&lt;0.001</u> | 35.6         | <u>&lt;0.001</u> |  |  |
|                               |                               | Treatment x Soil       | 1     | 0.1          | 0.816            | 2.0          | 0.160            | 0.1          | 0.715            | 2            | 1.0              | 0.613            | 0.7          | 0.705            | 1.6              | 0.439            | 2            | 0.6          | 0.755            | 0.6     | 0.724            | 1.7          | 0.422            |  |  |
|                               |                               | Treatment x Cross type | 1     | 0.5          | 0.471            | 0.7          | 0.397            | 2.0          | 0.159            | 2            | 1.2              | 0.537            | 0.2          | 0.924            | 1.9              | 0.394            | 2            | 3.6          | 0.166            | 6.7     | <b>0.034</b>     | 3.9          | 0.139            |  |  |
|                               |                               | Soil x Cross type      | 1     | 0.1          | 0.807            | 0.3          | 0.600            | 1.2          | 0.279            | 1            | 0.0              | 0.868            | 0.6          | 0.440            | 3.2              | 0.073            | 1            | 0.0          | 0.866            | 0.0     | 0.844            | 0.0          | 0.944            |  |  |
|                               | Treatment x Soil x Cross type | 1                      | 0.0   | 0.864        | 0.5              | 0.502        | 0.4              | 0.536        | 2                | 0.8          | 0.684            | 0.1              | 0.970        | 0.7              | 0.691            | 1                | 0.2          | 0.651        | 0.0              | 0.967   | 0.1              | 0.732        |                  |  |  |
|                               | Dam <sub>Pop</sub>            | 4                      | 12.5  | <b>0.014</b> | 12.0             | <b>0.017</b> | 13.9             | <b>0.008</b> | 8                | 11.8         | 0.158            | 12.9             | 0.117        | 9.0              | 0.338            | 8                | 12.0         | 0.151        | 7.2              | 0.517   | 20.5             | <b>0.009</b> |                  |  |  |
|                               | 2019                          | (Sample size)          |       |              | (58)             | (58)         | (58)             | (165)        | (161)            | (160)        |                  |                  |              |                  |                  |                  |              |              |                  |         |                  |              |                  |  |  |
|                               |                               | Treatment              | 2     | 6.2          | <b>0.045</b>     | 1.0          | 0.610            | 3.9          | 0.145            | 2            | 8.7              | <b>0.013</b>     | 48.8         | <u>&lt;0.001</u> | 76.2             | <u>&lt;0.001</u> | 2            | 7.6          | <b>0.023</b>     | 10.4    | <b>0.006</b>     | 14.5         | <u>&lt;0.001</u> |  |  |
|                               |                               | Soil                   | 1     | 9.4          | <u>&lt;0.001</u> | 5.6          | <b>0.018</b>     | 2.2          | 0.142            | 1            | 15.8             | <u>&lt;0.001</u> | 1.0          | 0.306            | 1.2              | 0.265            | 1            | 4.0          | <b>0.046</b>     | 2.5     | 0.117            | 0.0          | 0.933            |  |  |
|                               |                               | Cross type             | 1     | 2.6          | 0.109            | 2.1          | 0.147            | 3.9          | <b>0.048</b>     | 1            | 0.2              | 0.678            | 1.0          | 0.320            | 0.3              | 0.610            | 1            | 5.3          | <b>0.021</b>     | 5.5     | <b>0.019</b>     | 2.2          | 0.138            |  |  |
|                               |                               | Treatment x Soil       | 1     | 0.0          | 0.901            | 0.9          | 0.337            | 0.1          | 0.706            | 2            | 7.6              | <b>0.022</b>     | 4.9          | 0.085            | 13.0             | <u>&lt;0.001</u> | 2            | 33.3         | <u>&lt;0.001</u> | 6.5     | <b>0.038</b>     | 5.3          | 0.070            |  |  |
| Treatment x Cross type        |                               | 1                      | 0.9   | 0.339        | 0.3              | 0.570        | 0.1              | 0.818        | 2                | 1.0          | 0.616            | 10.9             | <b>0.004</b> | 11.5             | <b>0.003</b>     | 2                | 8.6          | <b>0.014</b> | 4.7              | 0.096   | 1.7              | 0.429        |                  |  |  |
| Soil x Cross type             |                               | 1                      | 0.3   | 0.593        | 0.6              | 0.452        | 0.2              | 0.670        | 1                | 1.1          | 0.288            | 0.3              | 0.590        | 0.7              | 0.417            | 1                | 0.8          | 0.386        | 1.1              | 0.302   | 1.3              | 0.249        |                  |  |  |
| Treatment x Soil x Cross type | 1                             | 0.7                    | 0.407 | 0.6          | 0.450            | 1.2          | 0.277            | 2            | 5.6              | 0.062        | 5.5              | 0.066            | 4.0          | 0.132            | 1                | 0.9              | 0.347        | 3.3          | 0.069            | 3.1     | 0.077            |              |                  |  |  |
| Dam <sub>Pop</sub>            | 4                             | 1.7                    | 0.784 | 1.5          | 0.820            | 4.5          | 0.343            | 8            | 19.7             | <b>0.012</b> | 25.0             | <b>0.002</b>     | 19.3         | <b>0.013</b>     | 8                | 21.2             | <b>0.007</b> | 16.5         | <b>0.036</b>     | 10.1    | 0.260            |              |                  |  |  |
| Outbreeding                   | 2018                          | (Sample size)          |       |              | (157)            | (157)        | (152)            | (297)        | (294)            |              |                  |                  |              |                  |                  |                  |              |              |                  |         |                  |              |                  |  |  |
|                               |                               | Treatment              | 2     | 16.2         | <u>&lt;0.001</u> | 22.6         | <u>&lt;0.001</u> | 30.3         | <u>&lt;0.001</u> | 2            | 41.5             | <u>&lt;0.001</u> | 49.9         | <u>&lt;0.001</u> | 31.1             | <u>&lt;0.001</u> | 2            | 2.4          | 0.300            | 4.9     | 0.085            | 2.2          | 0.329            |  |  |
|                               |                               | Soil                   | 1     | 89.8         | <u>&lt;0.001</u> | 89.6         | <u>&lt;0.001</u> | 84.8         | <u>&lt;0.001</u> | 1            | 242.3            | <u>&lt;0.001</u> | 277.6        | <u>&lt;0.001</u> | 262.0            | <u>&lt;0.001</u> | 1            | 203.0        | <u>&lt;0.001</u> | 215.0   | <u>&lt;0.001</u> | 213.5        | <u>&lt;0.001</u> |  |  |
|                               |                               | Cross type             | 2     | 23.7         | <u>&lt;0.001</u> | 18.0         | <u>&lt;0.001</u> | 19.1         | <u>&lt;0.001</u> | 2            | 12.7             | <b>0.002</b>     | 4.4          | 0.109            | 8.4              | <b>0.015</b>     | 2            | 2.8          | 0.241            | 2.9     | 0.231            | 9.6          | <b>0.008</b>     |  |  |
|                               |                               | Treatment x Soil       | 2     | 2.2          | 0.325            | 3.3          | 0.190            | 16.9         | <u>&lt;0.001</u> | 2            | 11.1             | <b>0.004</b>     | 1.4          | 0.487            | 5.2              | 0.074            | 2            | 4.8          | 0.090            | 2.0     | 0.364            | 1.9          | 0.395            |  |  |
|                               |                               | Treatment x Cross type | 4     | 2.9          | 0.576            | 4.4          | 0.358            | 0.6          | 0.964            | 4            | 9.5              | <b>0.050</b>     | 7.9          | 0.096            | 12.9             | <b>0.012</b>     | 4            | 4.5          | 0.339            | 4.9     | 0.299            | 4.4          | 0.350            |  |  |
|                               |                               | Soil x Cross type      | 2     | 0.2          | 0.926            | 1.6          | 0.451            | 5.4          | 0.067            | 2            | 1.5              | 0.467            | 0.2          | 0.903            | 1.8              | 0.399            | 2            | 15.4         | <u>&lt;0.001</u> | 8.1     | <b>0.017</b>     | 12.7         | <b>0.002</b>     |  |  |
|                               | Treatment x Soil x Cross type | 3                      | 1.9   | 0.599        | 2.3              | 0.521        | 0.4              | 0.947        | 4                | 2.1          | 0.724            | 5.9              | 0.210        | 7.0              | 0.135            | 4                | 5.1          | 0.274        | 3.6              | 0.466   | 4.9              | 0.299        |                  |  |  |
|                               | Dam <sub>Pop</sub>            | 4                      | 4.9   | 0.300        | 4.0              | 0.405        | 7.1              | 0.128        | 8                | 33.6         | <u>&lt;0.001</u> | 22.7             | <b>0.004</b> | 33.6             | <u>&lt;0.001</u> | 9                | 16.7         | 0.054        | 11.7             | 0.228   | 15.1             | 0.089        |                  |  |  |
|                               | 2019                          | (Sample size)          |       |              | (137)            | (137)        | (134)            | (284)        | (279)            | (278)        |                  |                  |              |                  |                  |                  |              |              |                  |         |                  |              |                  |  |  |
|                               |                               | Treatment              | 2     | 13.5         | <u>&lt;0.001</u> | 20.3         | <u>&lt;0.001</u> | 35.3         | <u>&lt;0.001</u> | 2            | 18.1             | <u>&lt;0.001</u> | 134.2        | <u>&lt;0.001</u> | 180.7            | <u>&lt;0.001</u> | 2            | 9.0          | <b>0.011</b>     | 44.4    | <u>&lt;0.001</u> | 36.5         | <u>&lt;0.001</u> |  |  |
|                               |                               | Soil                   | 1     | 15.9         | <u>&lt;0.001</u> | 20.5         | <u>&lt;0.001</u> | 4.0          | <b>0.047</b>     | 1            | 19.5             | <u>&lt;0.001</u> | 0.0          | 0.842            | 1.0              | 0.313            | 1            | 2.5          | 0.115            | 0.9     | 0.333            | 4.5          | <b>0.033</b>     |  |  |
|                               |                               | Cross type             | 2     | 0.7          | 0.697            | 0.8          | 0.675            | 1.7          | 0.419            | 2            | 30.8             | <u>&lt;0.001</u> | 36.4         | <u>&lt;0.001</u> | 26.5             | <u>&lt;0.001</u> | 2            | 3.5          | 0.174            | 4.1     | 0.128            | 2.3          | 0.322            |  |  |
|                               |                               | Treatment x Soil       | 2     | 1.0          | 0.604            | 0.7          | 0.705            | 3.3          | 0.189            | 2            | 19.4             | <u>&lt;0.001</u> | 9.5          | <b>0.009</b>     | 60.4             | <u>&lt;0.001</u> | 2            | 38.9         | <u>&lt;0.001</u> | 38.0    | <u>&lt;0.001</u> | 24.2         | <u>&lt;0.001</u> |  |  |
| Treatment x Cross type        |                               | 4                      | 4.5   | 0.337        | 2.6              | 0.631        | 1.8              | 0.771        | 4                | 5.8          | 0.216            | 3.2              | 0.525        | 11.4             | <b>0.022</b>     | 4                | 8.8          | 0.065        | 2.8              | 0.591   | 0.5              | 0.977        |                  |  |  |
| Soil x Cross type             |                               | 2                      | 2.0   | 0.366        | 2.3              | 0.311        | 2.0              | 0.376        | 2                | 3.3          | 0.189            | 1.8              | 0.415        | 4.2              | 0.121            | 2                | 2.2          | 0.338        | 2.1              | 0.345   | 1.7              | 0.431        |                  |  |  |
| Treatment x Soil x Cross type | 3                             | 3.4                    | 0.331 | 4.3          | 0.231            | 11.2         | <b>0.011</b>     | 4            | 1.4              | 0.844        | 0.9              | 0.924            | 3.2          | 0.518            | 4                | 14.7             | <b>0.005</b> | 1.8          | 0.771            | 1.2     | 0.881            |              |                  |  |  |
| Dam <sub>Pop</sub>            | 4                             | 0.7                    | 0.948 | 1.7          | 0.796            | 2.7          | 0.606            | 8            | 5.0              | 0.754        | 10.3             | 0.246            | 11.7         | 0.166            | 9                | 19.1             | <b>0.024</b> | 17.6         | <b>0.040</b>     | 5.3     | 0.803            |              |                  |  |  |

Electronic Appendix 11. – Analysis of plant survival between 2018 and 2019. Significant values are in bold.

|                        | Df | Deviance | p-value          |
|------------------------|----|----------|------------------|
| Treatment              | 2  | 370.56   | <b>&lt;0.001</b> |
| Soil                   | 1  | 327.83   | 0.108            |
| Pop                    | 2  | 339.62   | <b>0.001</b>     |
| Cross type             | 4  | 336.71   | <b>0.022</b>     |
| Treatment x Soil       | 2  | 288.84   | 0.526            |
| Treatment x Pop        | 4  | 289.98   | 0.657            |
| Treatment x Cross type | 8  | 304.25   | <b>0.033</b>     |
| Soil x Pop             | 2  | 289.15   | 0.450            |
| Soil x Cross type      | 4  | 291.63   | 0.396            |
| Pop x Cross type       | 5  | 299.45   | <b>0.036</b>     |



Electronic Appendix 12. – Partial regression plots of inbreeding (left panels) and outbreeding (right panels) depression as a function of environmental stress (top), coefficient of variation (middle), and the relationship between the coefficient of variation and environment stress (bottom).



Electronic Appendix 13. – Late cycle trait means per population and per year. To avoid the effects of the cross type, only data from within population outbred offspring is used.

Electronic appendix 14. Cumulative estimates of inbreeding depression and heterosis. Estimates were made by combining one early cycle trait (pollination success or seed number), germination as mid cycle trait, and one late cycle trait (plant width, number of stems or flower set). Cell colours correspond to the effect of cross type on the offspring fitness. Red – fitness decrease (inbreeding or outbreeding depression), blue – fitness increase (inbreeding benefit or heterosis) relative to the within-population outcrossed offspring.

|                           |    | Z1     |          |            | Z2    |          |            | Z6     |          |            |        |        |
|---------------------------|----|--------|----------|------------|-------|----------|------------|--------|----------|------------|--------|--------|
|                           |    | Width  | N° stems | Flower set | Width | N° stems | Flower set | Width  | N° stems | Flower set |        |        |
| <b><u>Inbreeding</u></b>  |    |        |          |            |       |          |            |        |          |            |        |        |
| Seed production           |    | 0.388  | 0.486    | 0.467      | 0.634 | 0.622    | 0.704      | 0.458  | 0.396    | 0.766      |        |        |
| Seed number               |    | 0.536  | 0.610    | 0.596      | 0.653 | 0.642    | 0.719      | 0.676  | 0.639    | 0.860      |        |        |
| <b><u>Outbreeding</u></b> |    |        |          |            |       |          |            |        |          |            |        |        |
| Seed production           | Z6 | -0.150 | -0.318   | -0.141     | Z6    | 0.102    | -0.156     | -0.022 | Z1       | -0.516     | -0.360 | -1.868 |
|                           | Z2 | -0.277 | -0.232   | -0.276     | Z1    | -0.054   | -0.063     | -0.078 | Z2       | -0.276     | 0.015  | -1.576 |
| Seed number               | Z6 | 0.047  | -0.092   | 0.055      | Z6    | 0.083    | -0.181     | -0.044 | Z1       | -1.119     | -0.900 | -3.008 |
|                           | Z2 | -0.264 | -0.219   | -0.263     | Z1    | -0.004   | -0.012     | -0.026 | Z2       | -0.204     | 0.071  | -1.430 |