**Electronic supplementary material**

Rapid and positive responses of plants to lower precipitation predictability

Martí March-Salas\*, Mark van Kleunen; Patrick S. Fitze\*

\*Corresponding authors - [patrick.fitze@mncn.csic.es](mailto:patrick.fitze@mncn.csic.es)

- [martimarchsalas@gmail.com](mailto:martimarchsalas@gmail.com)

Proceedings of the Royal Society B: Biological Sciences

doi: 10.1098/rspb.2019.

**Content of the Supplemental material Page number**

Supplemental text:

* Study species 3
* Seed origin 4
* Experimental system and sowing protocol 4
* Precipitation regime 6
* Experimental protocol used for descendants 7
* References 8

Supplemental tables:

* Table-S1 9
* Table-S2 (A, B) 10, 11
* Table-S3 12
* Table-S4 13

Supplemental figures:

* Figure-S1 14
* Figure-S2 15
* Figure-S3 16
* Figure-S4 17
* Figure-S5 18

**Supplemental Material**

***Supplemental text:***

**Study species**

*Papaver rhoeas* and *Onobrychis viciifolia* were used for the study because their reproductive strategy differs, because the timing of growth is similar, and because wild individuals of both plant species occur at the study site. Both species inhabit humid sites and sites with more and also with less humidity than the conditions at the study site (e.g. [20,27]).

*Papaver rhoeas* (common poppy) is an herbaceous annual plant that grows from sea level to 1700 m a.s.l. Its main distribution is in Eurasia and northern Africa. Its height is between 10 and 50(90) cm, and the flowers are bright red and almost spherical [28]. Flowering begins in May and can last until October, and a single individual can produce more than 30 flowers throughout the season. The fruit is a capsule that, when ripe (July – September), opens apical holes from which numerous >1 mm long, kidney-shaped seeds are dispersed [27].

*Onobrychis viciifolia* (common sainfoin) is a perennial forb that grows from sea level to 2800 m a.s.l. The native distribution is in the Mediterranean, south-eastern Europe and Siberia, but it is also widely naturalized in other parts of Eurasia, North America, Australia and New Zealand. *Onobrychis viciifolia* inhabits a broad range of climatic weather conditions [20]. Its height is between 20 and 80 cm (sometimes > 100 cm), and it produces dense inflorescences with 10-100 pink, zygomorphic, hermaphroditic flowers. A single individual can produce more than 60 inflorescences throughout the season. Its flowering period is from June to September. The fruit is a small single-seeded pod. Sainfoin is a forage legume, which is grown in many parts of the world [29].

**Seed origin**

Seeds of both species were obtained in 2011 from sites located in the vicinity of the study site, but not from the actual study site to make sure that seeds were naive with regard to the environmental conditions prevailing at the experimental field site. These sites exhibit higher precipitation than the study site, but otherwise a similar climate. Seeds of *O. viciifolia* originated from a farm located in Castillo de Lerés (23 km from the field site), which exhibits more precipitation than the field site (on average, approx. 340 mm more per year), and seeds of *P. rhoeas* originated from a farm located in the Ebro Valley (ca. 75 km from the field site). Since these seeds were never exposed to the weather conditions prevailing at the study site, we refer to these seeds as the ancestral generation (G0).

**Experimental system, sowing, and thinning protocol**

All experiments were conducted at the experimental station ‘El Boalar’ (42°33’N, 0°37’W, 705 m.a.s.l.; IPE-CSIC, Jaca (Huesca), Spain). In 2012, we established 32 experimental plots of 1.2 × 6.0 m in 16 open-air enclosures (two plots per enclosure, one for each species; a total of 16 plots for *P. rhoeas*, and 16 for *O. viciifolia*; Fig. S2). Enclosures were covered with a mesh and separated with a metal wall that prevented ruminants from grassing. Prior to the start of the experiment, the first 30 cm of soil of each plot was loosened and homogenised. All visible weeds, roots and seeds were removed to avoid competition with other plant species, and then the ground was flattened. In each plot, 28 well-separated planting positions were marked (Fig. S2). Moreover, to protect against slug predation, each plot was surrounded with a mesh (30 cm above ground and 10 cm below ground).

Randomly chosen seeds of the ancestral generation (G0) of *O. viciifolia* and *P. rhoeas*,were sown on the same day in early April in four consecutive years (2012-2015). In 2012, three seeds per species, enclosure, and position were individually labelled (3 × 16 × 28 = 1344 seeds per species), and planted at a depth of 2 and 1 cm for *O. viciifolia* and *P. rhoeas*, respectively, allowing to follow each individual over the entire annual cycle. In the following years, four and nine seeds per position (for *O. viciifolia* and *P. rhoeas*, respectively) were planted, to increase the chance that at least one plant would be growing per planting position. Before sowing, we statistically tested that there were no significant differences in average seed mass and variance between seeds selected and not selected to be sown, and used in different years, plots, and experimental treatments (all *P* ≥ 0.1, including all interactions). When the first seedling reached a height of 5 cm in *P. rhoeas* and 10 cm in *O. viciifolia*, the height, diameter, and growth rate (in height and diameter) of all seedlings was measured. In the case that several seedlings emerged in the same planting position, all but one seedling were thinned per position in 2012 to avoid competition among plants as much as possible. In the following years all but one seedling were thinned in *O*. *viciifolia* and all but three seedlings were thinned per position in *P. rhoeas* (*i.e.* three ‘sub-positions’ existed per position, and the probability that at least one planted seed per sub-position germinated was used to calculate the probability of seed production). There were no significant differences in days to seedling emergence, seedling height, seedling diameter, and growth rate between thinned and non-thinned seedlings, and all interactions between thinning and plot or intrinsic predictability treatment were not significant (all *P* ≥ 0.8).

**Precipitation regime**

The natural precipitation pattern (Fig. S3) was manipulated by supplementing half of the enclosures with more predictable and the other half with less predictable supplemental precipitation by means of sprinklers, resulting in more predictable (M) and less predictable (L) total (natural + supplemental) precipitation. L- and M-plots, received the same total amount of precipitation and permutation entropy [2] showed that the intrinsic precipitation predictability of the total precipitation significantly differed among treatment levels [19]. The treatment therefore corresponds to more and less predictable precipitation (Fig. S5). Thereafter, *i.e.*, during the late growth period (which approximately corresponds to summer), enclosures were exposed to the same or the other predictability regime using a two-factorial design (Fig. S1), to simulated inter-seasonal differences in intrinsic predictability. The two-factorial design consisted of: intra- and inter-seasonal (*i.e.* early growth period vs late growth period) predictability; resulting in four different regimes of intrinsic environmental predictability (*i.e.* four treatment combinations): (1) less predictable during early growth and less predictable during late growth (LL), (2) more predictable in both periods (MM), (3) less predictable during early and more predictable during late growth (LM), and (4) more predictable during early and less predictable during late growth (ML). Enclosures were irrigated individually using an automatic irrigation system and four sprinklers per enclosure, one in each corner, to provide homogenous irrigation in the whole enclosure. Each year, irrigation treatments started shortly before sowing and ended after plant harvesting (*i.e.* from mid-March to mid-October), and treatments were changed in the middle of the plant’s phenological cycle (at the end of June/beginning of July) to manipulate the intrinsic predictability between spring and summer seasons (*i.e.* inter-seasonal predictability). Experimental plots of the same plant species were 10 to 50 m away from the closest plot belonging to the same treatment and plots were separated by metal walls and mesh.

**Experimental protocol used for descendants**

To test whether treatments induce differences in the direction and strength of transgenerational responses, produced seeds were stored during winter. In the following spring, a random subsample of mothers (a similar number of mothers from each plot and treatment combination: 7-8 mothers) and a random subsample of the seeds produced by them (a similar number of seeds per mother) was selected, planted and followed up. Seeds were sown in the same treatment combination experienced by their mother (Fig. S1), but not in the plot where the mother has been growing, to avoid transgenerational responses with respect to plot-specific idiosyncrasies. Before sowing, we statistically tested that there were no significant differences between the selected and not selected mothers in the mean and variance of the emergence time (days), maximum height (in mm), maximum diameter (mm), number and mass of produced seeds, and flowering period among treatment combinations, mother enclosure, and treatment × mother enclosure combinations (all *P* > 0.2). Similarly, we tested that the mean and variance of the seed mass of selected and not selected seeds (per mother) did not differ (*P* ≥ 0.1). The number of selected mothers of each treatment combination was as similar as possible and did not significantly differ among treatment combinations in any year (*P* ≥ 0.1).

Seeds belonging to the subset of a given mother were equally distributed among one to three plots that were exposed to the treatment combination experienced by the mother, and seeds were not planted in the plot where the mother had been growing to avoid local adaptation to the conditions of a particular enclosure.

**References**

27. McNaughton IH, Harper JL. 1964 Papaver L. *J. Ecol.* **52**, 767–793. (doi: 10.2307/2257860)

28. Franklin-Tong VE, Franklin FCH. 1992 Gametophytic self-incompatibility in Papaver rhoeas L. *Sex. Plant Reprod.* **5**, 1–7. (doi:10.1007/BF00714552)

29. Liu Z, Lane GPF, Davies WP. 2008 Establishment and production of common sainfoin (Onobrychis viciifolia Scop.) in the UK. 1. Effects of sowing date and autumn management on establishment and yield. *Grass Forage Sci.* **63**, 234–241. (doi:10.1111/j.1365-2494.2008.00628.x)

**Supplemental Tables**

**Table-S1:** Treatment effects on ancestors (G0) of *P. rhoeas* and *O. viciifolia* across four years. Analysed traits are:Time (*t*) to emergence (in days), *t* to flowering (in weeks), probability (*P*) of seed production, number (*N*) of seeds produced, and average (**Ø**) seed mass (in g). Shown are results of minimal adequate models resulting from stepwise backward model selection. All significant parameters are shown, while non-significant parameters included in the minimal adequate model are not shown here, but are given in Table S2A. Test statistics and significance levels (\* 0.05 > *P* ≥ 0.01; \*\* 0.01 > *P* ≥ 0.001; \*\*\* *P <* 0.001) are given. Early and Late refer to the treatment applied during the early and late growth season. For main effects of the early and late predictability treatment, estimates ± standard errors for the more predictable treatment (M) (compared to L) are given. These estimates refer to estimates of the treatment effect across years. *N* refers to the analysis’ sample size.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Papaver rhoeas*** | | | | | |
| **Response variable** | **Parameter** | ***Test statistic*** | ***P*** | **Estimate±SE** | ***N*** |
| ***t* to emergence** ƒ | Early [M] | χ12 = 4.77 | \* | 1.584 ± .797 | 1304 |
|  | Year | χ32 = 255.10 | \*\*\* |  |  |
| ***t* to flowering †** | Late [M] | χ12 = 8.81 | \*\* | .031 ± .010 | 457 |
|  | Year | χ32 = 59.40 | \*\*\* |  |  |
| ***P* seed production** | Early [M] | χ12 = 4.49 | \* | -2.062 ± .384 | 1456 |
|  | Early × Year | χ32 = 30.54 | \*\*\* |  |  |
|  | Late × Year | χ32 = 17.12 | \*\* |  |  |
|  | Year | χ32 = 18.95 | \*\*\* |  |  |
| **Øseed mass** ‡ | Late [M] | χ12 = 34.73 | \*\*\* | -.052 ± .009 | 384 |
|  | Year | χ32 = 59.40 | \*\*\* |  |  |
| ***Onobrychis viciifolia*** | | | | | |
| **Response variable** | **Parameter** | **Test statistic** | ***P*** | **Estimate±SE** | ***N*** |
| ***t* to emergence** | Early [M] | χ12 = 3.95 | \* | .041 ± .020 | 1366 |
|  | Year | χ32 = 115.26 | \*\*\* |  |  |
| ***t* to flowering** § | Late [M] | χ12 = 20.65 | \*\*\* | .186 ± .041 | 211 |
|  | Year | χ32 = 127.65 | \*\*\* |  |  |
| ***P* seed production** | Early [M] | χ12 = 15.83 | \*\*\* | -.916 ± .230 | 784 |
|  | Late [M] | χ12 = 4.01 | \* | -.458 ± .229 |  |
|  | Year | χ32 = 40.77 | \* |  |  |
| ***N* seeds produced** # | Late [M] | χ12 = 7.81 | \*\* | -.902 ± .323 | 211 |
|  | Year | χ32 = 30.34 | \*\*\* |  |  |
| **Ø seed mass ∫** | Late [M] | χ12 = 6.84 | \*\* | .230 ± .135 | 211 |
|  | Year | χ32 = 28.49 | \*\*\* |  |  |
|  | Late × Year | χ32 = 10.78 | \* |  |  |
|  | Early × Late × Year | χ32 = 14.82 | \*\* |  |  |

transformations: ƒ^-1.8; **†**^0.2; §ln; #^0.4; ‡^0.55; ∫scaled variable

**Table-S2:** Fixed parameters included in the statistical analyses of the traits analysed in the full models for *P. rhoeas* and *O. viciifolia*. **A.** Results of the full models on the ancestral generation (G0; *see* Table S1 for reduced models). **B.** Results of the full models on the ancestral and descendant generation that allow testing for a transgenerational response (*see* Table S4 for reduced models). Shown are all fixed parameters included in the full model. Non-significant parameters that were excluded during the stepwise backward elimination are indicated with an ‘X’. The significance level of parameters included in the minimal adequate models is given with asterisks (\* 0.05 > *P* ≥ 0.01; \*\* 0.01 > *P* ≥ 0.001; \*\*\* *P* < 0.001), or with ‘-’ for non-significant parameters. Because emergence only occurred during the early treatment, late treatment and interactions including late treatment were not included in the model on time to emergence.

**A.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sps. | *Variables* \ Parameters | **Early** | **Late** | **Year** | **Early × Late** | **Early × Year** | **Late × Year** | **Early × Late × Year** |
| *Papaver rhoeas* | ***t* to emergence** | \* |  | \*\*\* |  | X |  |  |
| ***t* to flowering** | X | \*\* | \*\*\* | X | X | X | X |
| ***P* seed production** | \* | - | \*\*\* | X | \*\*\* | \*\* | X |
| ***N* seeds produced** | X | X | X | X | X | X | X |
| **Øseed mass** | X | \*\*\* | \*\*\* | X | X | X | X |
| *Onobrychis viciifolia* | ***t* to emergence** | \* |  | \*\*\* |  | X |  |  |
| ***t* to flowering** | X | \*\*\* | \*\*\* | X | X | X | X |
| ***P* seed production** | \*\*\* | \* | \* | X | X | X | X |
| ***N* seeds produced** | X | \*\* | \*\*\* | X | X | X | X |
| **Øseed mass** | - | \*\* | \*\*\* | - | - | \* | \*\* |

*\*‘plot’ was included as random factor in every model shown in this table.*

**B.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sps. | *Variables* \ Parameters | **Early** | **Late** | **Year** | **PTR** | **Early × Late** | **Early × PTR** | **Early × Year** | **Late × PTR** | **Late × Year** | **Year × PTR** | **Early × Late × PTR** | **Early × Late × Year** | **Early × Year × PTR** | **Late × Year × PTR** | **Early × Late × Year × PTR** |
| *Papaver rhoeas* | ***t* to emergence** | \* |  | \*\*\* | \* |  | - | - |  |  | \*\*\* |  |  | \*\* |  |  |
| ***t* to flowering** | X | X | \*\*\* | \*\*\* | X | X | X | X | X | \*\*\* | X | X | X | X | X |
| ***P* seed production** | X | - | \*\*\* | \*\*\* | X | X | X | X | \*\*\* | \*\*\* | X | X | X | X | X |
| ***N* seeds produced** | X | X | \*\*\* | X | X | X | X | X | X | X | X | X | X | X | X |
| **Øseed mass** | - | \*\*\* | \*\*\* | \* | X | \* | X | \* | X | \*\* | X | X | X | X | X |
| *Onobrychis viciifolia* | ***t* to emergence** | \* |  | \*\* | - |  | X | X |  |  | \*\* |  |  | X |  |  |
| ***t* to flowering** | \* | \*\* | \*\*\* | - | X | \* | \* | X | X | \* | X | X | X | X | X |
| ***P* seed production** | \*\*\* | \*\* | \*\*\* | - | X | \* | - | X | X | - | X | X | \* | X | X |
| ***N* seeds produced** | - | - | \* | - | - | - | X | - | X | X | \* | X | X | X | X |

*\*‘plot’ and ‘matriline ID’ were included as random factors in every model shown in this table.*

**Table-S3:** Fitness correlates in *P.* *rhoeas* and *O. viciifolia*. Results of multiple regression on multiplicative fitness components: probability (*P*) of seedling emergence, probability (*P*) of seed production, number (*N*) of seeds produced, and average (Ø) seed mass. As independent para-meter we used seed mass of the initially sown seeds (initial seed mass), time (*t*) to emergence, time (*t*) to flowering, and average (Ø) seed mass. Test statistics, significance (*P*-value), and estimates ± standard errors are given. R2 refers to partial R2, *i.e.*, the variance explained by a model parameter. Transformations of the response variables are indicated below the table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Response variable** | **Parameter** | ***Test statistic*** | ***P*** | **Estimate ± SE** | **R2** |
|  |  |  |  |  |  |
| ***Papaver rhoeas*** | | | | | |
| ***P of emergence*** |  |  |  |  |  |
|  | initial seed mass | χ12 = 2.70 | .100 | 1469.9 ± 893.4 | .23 |
| ***P* seed production** |  |  |  |  |  |
|  | initial seed mass | χ12 = .09 | .762 | 428.5 ± 1410.9 | .02 |
|  | *t* to emergence | χ12 = 2.87 | .090 | .018 ± .011 | .67 |
| ***N* seeds produced** \* |  |  |  |  |  |
|  | initial seed mass | F1,127 = 7.73 | .006 | **.003 ± .001** | **.15** |
|  | *t* to emergence | F1,126 = 3.19 | .076 | .013 ± .007 | 3.32 |
|  | *t* to flowering | F1,125 = 2.76 | .096 | -.049 ± .029 | .80 |
|  | Ø seed mass | F1,127 = 44.97 | <.001 | **-.007 ± .001** | **13.21** |
| **Ø seed mass †** |  |  |  |  |  |
|  | initial seed mass | F1,129 = 1.16 | .284 | 3.8 ± 4.15 | 1.17 |
|  | *t* to emergence | F1,130 = 14.22 | <.001 | **-9.6E-05 ± 2.6E-05** | **11.54** |
|  | *t* to flowering | F1,127 = .03 | .867 | 1.8E-05 ± 1.1E-04 | .01 |
|  | *N* seeds produced | F1,130 = 38.29 | <.001 | **-2.4E-07 ± 3.9E-08** | **20.13** |
|  |  |  |  |  |  |
| ***Onobrychis viciiolia*** | | | | | |
| ***P of emergence*** |  |  |  |  |  |
|  | initial seed mass | χ12 = .04 | .833 | 6.0E-05 ± 2.9E-04 | .00 |
| ***P* seed production** |  |  |  |  |  |
|  | initial seed mass | χ12 = .05 | .819 | -7.56 ± 33.05 | .02 |
|  | *t* to emergence | χ12 = 7.51 | <.001 | **-.073 ± .037** | **2.19** |
| ***N* seeds produced †** |  |  |  |  |  |
|  | initial seed mass | F1,114 = .19 | .660 | 54.143 ± 122.827 | .32 |
|  | *t* to emergence | F1,116 = 2.82 | .096 | -.284 ± .165 | 4.17 |
|  | *t* to flowering | F1,116 = 16.32 | <.001 | **-.664 ± .163** | **10.77** |
|  | Ø seed mass | F1,115 = .43 | .512 | -45.541 ± 70.583 | .36 |
| **Ø seed mass \*** |  |  |  |  |  |
|  | Initial seed mass | F1,116 = .36 | .549 | .467 ± .700 | .36 |
|  | *t* to emergence | F1,117 = 2.32 | .130 | .003 ± .003 | 3.15 |
|  | *t* to flowering | F1,118 = 24.40 | <.001 | **-.005 ± .001** | **17.13** |
|  | *N* seeds produced | F1,114 = .01 | .938 | 1.6E-06 ± 2.6E-05 | 1.90 |

Transformations: \*^0.20; **†**^0.5

**Table-S4:** Transgenerational responses of *P. rhoeas* and *O. viciifolia* in:Time (*t*) to emergence (days); *t* to flowering (weeks); probability (*P*) of producing at least one seed per planted seed (*Pseed production*); number of seeds produced; average seed mass (g). While ancestors were unable to do a potential transgenerational response (PTR), descendants may have exhibited a PTR. Since only significant treatment × PTR interactions point to transgenerational responses with respect to the precipitation treatments, we only show significant interactions including PTR as well as simple PTR effects (for full models, *see* table S2B). Test statistic and significance (\* 0.05 > *P* ≥ 0.01; \*\* 0.01 > *P* ≥ 0.001; \*\*\* *P <* 0.001) are given. Estimates ± standard errors of main effects are given for descendants compared to ancestors. *N* refers to the analysis’ sample size. Early and Late refer to the predictability treatment during the early and late growth period.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Papaver rhoeas*** | | | | | |
| **Response variable** | **Parameter** | ***Test statistic*** | ***P*** | **Estimate±SE** | ***N*** |
|  |  |  |  |  |  |
| ***t* to emergence** ƒ |  |  |  |  |  |
|  | PTR [descendants] | χ12 = 3.83 | \* | .003 ± .006 | 1410 |
|  | Year × PTR | χ22 = 199.55 | \*\*\* |  |  |
|  | Early × Year × PTR | χ22 = 11.39 | \*\* |  |  |
| ***t* to flowering †** |  |  |  |  |  |
|  | Year × PTR | χ22 = 5.98 | \* |  | 466 |
| ***P* seed production** |  |  |  |  |  |
|  | PTR[descendants] | χ12 = 15.54 | \*\*\* | .002 ± .182 | 2060 |
|  | Year × PTR | χ22 = 15.22 | \*\*\* |  |  |
| **Ø seed mass** ‡ |  |  |  |  |  |
|  | PTR[descendants] | χ12 = 4.01 | \* | .024 ± .017 | 450 |
|  | Early × PTR | χ12 = 6.05 | \* |  |  |
|  | Late × PTR | χ12 = 4.74 | \* |  |  |
|  | Year × PTR | χ22 = 12.38 | \*\* |  |  |
|  |  |  |  |  |  |
| ***Onobrychis viciifolia*** | | | | | |
| **Response variable** | **Parameter** | ***Test statistic*** | ***P*** | **Estimate±SE** | ***N*** |
|  |  |  |  |  |  |
| ***t* to emergence ß** |  |  |  |  |  |
|  | Year × PTR | χ22 = 12.86 | \*\* |  | 998 |
| ***t* to flowering** £ |  |  |  |  |  |
|  | Early × PTR | χ12 = 4.83 | \* |  | 177 |
|  | Year × PTR | χ22 = 6.06 | \* |  |  |
| ***P* seed production** |  |  |  |  |  |
|  | Early × PTR | χ12 = 4.32 | \* |  | 467 |
|  | Early × Year × PTR | χ22 = 6.00 | \* |  |  |
| ***N* seeds produced** # |  |  |  |  |  |
|  | Early × Late × PTR | χ12 = 3.908 | \* |  | 177 |

Transformations: ƒ^-1.5; **†**ln; #^0.4; £^0.5; ‡^0.64; ß^-1.9**Supplemental Figures**



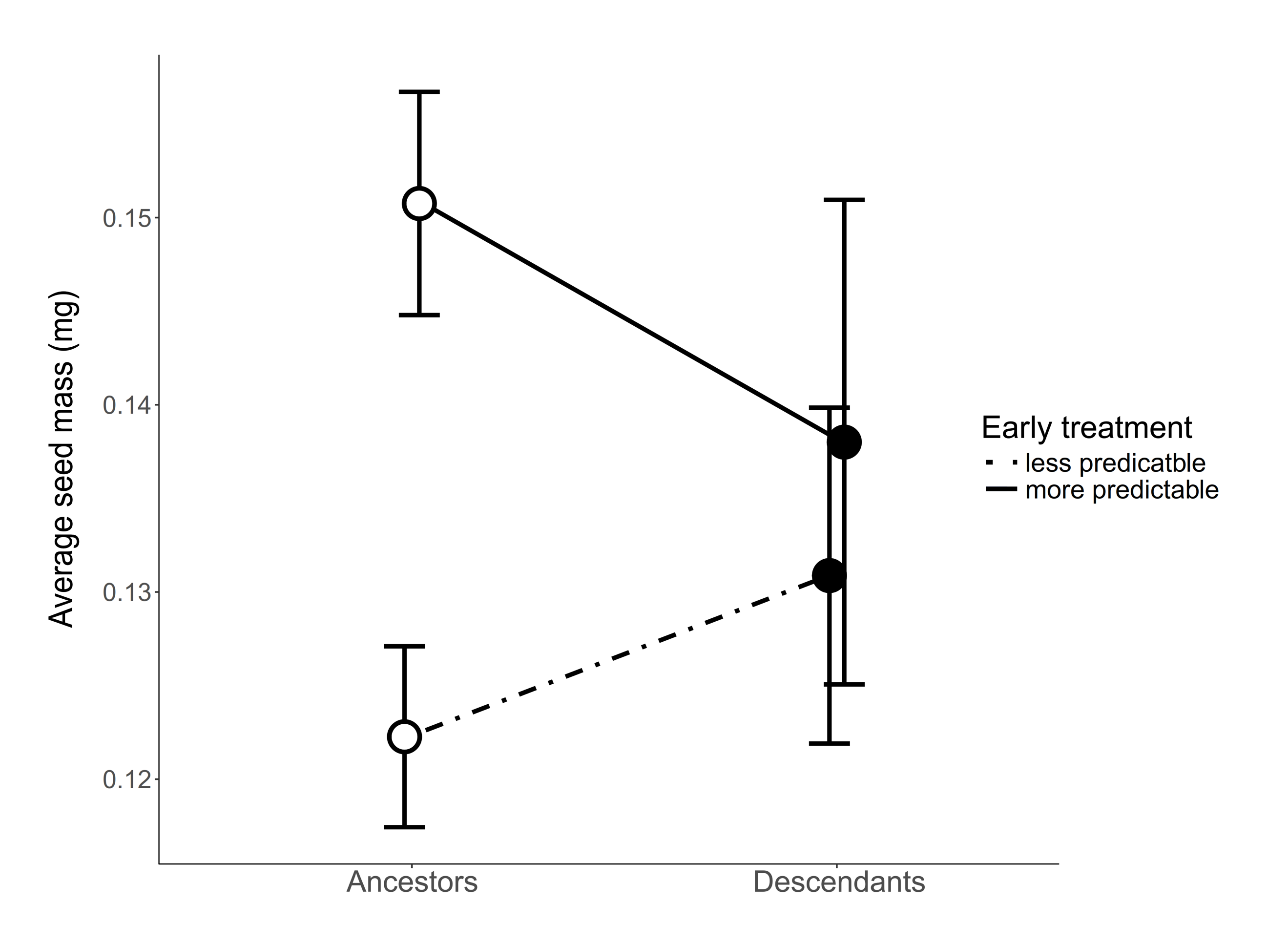
**Figure-S1:** Two factorial within-year design of intrinsic environmental predictability with factors intra- and inter-seasonal predictability simulated in four consecutive years (*see* upper line of each treatment combination). Intra-seasonal predictability consisted of two levels: less (red colour) and more predictable precipitation (blue colour), corresponding to lower and higher autocorrelation of daily precipitation. Inter-seasonal predictability consisted of two levels: higher precipitation predictability between the early and late growth season (MM, LL) vs lower precipitation predictability (ML, LM), or in other words, to higher and lower autocorrelation between seasons. To test for the consistency of the treatment effects, ancestor seeds (G0) were planted in four experimental years (upper line of each treatment combination). To test for transgenerational responses to the simulated predictability regimes, descendants were planted in three years, allowing to track transgenerational responses over three descendant generations (G1 to G3; *see* lower line of each treatment combination), and individuals belonging to the same maternal line (*i.e.* matriline) were exposed to the same intra- and inter-seasonal predictability regime. Treatments on the same dotted line correspond: to the same individual within years (fine dotted line), and among years, to the same maternal line (thick dotted line).

******

**Figure-S2:** Experimental system located at ‘El Boalar’, consisting of 16 enclosures. In each enclosure, two plots were established: one for *P. rhoeas*, and another one for *O. viciifolia.* Shown are schemas of the arrangement of the plots (left to the photo) and the planting positions within a plot (above the photo), and a photograph of the experimental system. Planting positions (red dots) were 40 cm away from each other and from the borders of the plot, to avoid competition with other plants [29]. More than one seed was sown per position to increase the chance that at least one seedling per position emerged. If more than one seedling emerged per position, they were thinned (for additional details, *see* ‘Methods’ and ‘Supplemental text’).

C:\Users\Marti\Desktop\PhD PAPERS\PAPER 3 - Viability - Emergence and Survival\Graphs\Fig. S4. PANEL_001.tif

**Figure S3:** Monthly natural precipitation and average temperature in each year in Jaca (Huesca, Spain), where experiment was conducted. **A.** Monthly precipitation (in mm) in each year. **B.** Average monthly temperatures (in ºC) in each year. Colored lines represent different experimental years (2012-2015).



**Figure-S4:** Transgenerational response of *P. rhoeas* on average seed mass (significant interaction of early treatment and PTR; Table S4). The dashed line represents the less predictable treatment (L) and the solid line the more predictable treatment (M). Average seed mass of ancestors and descendants are shown with circles with a black outline and filled circles, respectively.

**Figure-S5:** Intrinsic precipitation predictability of plots exposed to more (panel A) and less (panel B) predictable total (natural + supplemental) precipitation. Shown is the amount of precipitation per experimental day. Experimental days refer to the days from sowing to harvesting and data from different experimental years (2012-2015) are concatenated. In both treatment levels, the total amount of precipitation over the duration of the entire experiment was identical (χ2 < 0.001, *P* = 0.992), and the autocorrelation of total precipitation between days was significantly higher in the more predictable treatment (χ2 = 605.49, *P* < 0.001).

