**Supplementary Information**

**Title:** Effects of Resource Availability on Seedlings of Invasive Liana, *Clematis vitalba*

Authors: Brenda Jarvis-Lowry1, Kerry C. Harrington1,Hossein Ghanizadeh1, Alastair W. Robertson2

1 School of Agriculture and Environment, Massey University, Palmerston North, New Zealand

2 School of Natural Sciences, Massey University, Palmerston North, New Zealand

Corresponding author:Alastair Robertson, email: A.W.Robertson@massey.ac.nz

**Table S1**. Soil characteristics. The experiment locations: Manuka 1 and 2 (M1 and M2) are adjacent, largely open, ungrazed sites and were sampled as one location, in December 2019; Treeline (TL) is a recently grazed site underneath a windbreak, sampled in November 2020.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Site | RatioSand:silt:clay | pH | %OMa | Olsen P mg/L | Kme/100g | Came/100g | Mgme/100g | Name/100g | CECme/100g | % Base Saturation |
| M 1 & M2 | 8:69:23 | 5.9 | 8.94 | 48 | 1.17 | 7.7 | 1.48 | 0.14 | 17 | 62 |
| TL | 7:66:27 | 5.9 | 21.40 | 41 | 1.33 | 10.5 | 5.16 | 1.16 | 33 | 56 |

aOM = organic matter; CEC = cation exchange capacity; me/100 g = milliequivalents per 100 grams of soil

**Notes on site soil characteristics.** At TL, the ubiquitous presence of shallow tree roots made it difficult both to obtain sufficiently deep soil cores and to completely remove the grass root system. Nutrients are stratified in the soil, with more in the upper than lower parts (Brady and Weil 1999). This stratification was reflected in elevated levels of base minerals, organic matter and cation exchange capacity at TL, likely due to the shallowness of the samples. Also, because of recent grazing at the site, stock sheltering underneath the trees from adverse weather could have contributed to the higher cation levels by their excretions. At M1 and M2, which had not been grazed in several years, no excretions or fertilizer had been added.

**Figure S1**: Mean total monthly rainfall (mm), mean monthly minimum (Tmin) and maximum (Tmax) temperature (°C), and daylength (hrs) over the duration of the three experiments (Experiment M1: November 2019-November 2020; Experiments M2 and TL: September 2020-September 2021).

**Table S2**. Poisson generalised linear mixed model summary for *Clematis vitalba* seedling survivability (percentage of 100 seeds sown that established as seedlings) at Manuka 1 site 10 and 52 weeks after sowing. P-values in bold are significant at α=0.001.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Wk 10** |   |   |   | **Wk 52** |   |   |   |
| Random effects | VAR | SD |  | VAR | SD |  |
| block(intercept) | 0.105 | 0.324 |  | 0.092 | 0.304 |  |
| Fixed effects | Est | SE | Pr (>|z|) | Est | SE | Pr (>|z|) |
| intercept | 2.145 | 0.205 | **<0.001** | 1.826 | 0.26 | **<0.001** |
| Treatment Cut | 0.28 | 0.237 | 0.237 | -29.603 | 2048 | 0.988 |

**Table S3.** Poisson generalised linear mixed model summary for *Clematis vitalba* seedling survivability (percentage of 100 seeds sown that established as seedlings) at the Mānuka 2 site (M2), 10 weeks after sowing. Significant pairwise comparisons from simultaneous tests for general linear hypotheses are also given. P-values significant at α=0.001 are in bold.

|  |  |
| --- | --- |
|  **10 weeks after sowing**    |   |
| Random effects | VAR | SD |  |
| block(intercept) | 0.223 | 0.472 |  |
| Fixed effects | Est | SE | Pr (>|z|) |
| intercept | 7.263 | 0.237 | **<0.001** |
| treatment IBarea | -1.258 | 0.034 | **<0.001** |
| Treatment Cut | -0.227 | 0.024 | **<0.001** |
|  |  |  |  |
| Multiple Comparisons of Means: Tukey Contrasts |
|  | Est | SE | Pr (>|z|)  |
| IBare-Bare==0 | -1.258 | 0.034 | **<0.001** |
| Cut-Bare==0 | -0.227 | 0.024 | **<0.001** |
| Cut-Ibare==0 | 1.031 | 0.035 | **<0.001** |

a Bare = reference category; plots maintained bare (bare at the time of sowing, kept weeded and trimmed throughout the experiment); IBare = plots initially bare (bare at the time of sowing, but not weeded or trimmed thereafter); Cut = vegetation in plots cut to ~ 4cm at the time of sowing, but not trimmed again.

**Table S4.** Generalised linear mixed model summary (negative binomial (NB) and Poisson) for *Clematis vitalba* seedling survivability (percentage of 100 seeds sown that established as seedlings) at the Treeline site (TL) 52 and 61 weeks after sowing, with significant pairwise comparisons from simultaneous tests for general linear hypotheses. P-values significant at α=0.05 are in bold.

|  |  |
| --- | --- |
| **Week 52 Poisson model** | **Week 61 negative binomial model** |
| Random effects | VAR | SD |  | VAR | SD |  |
| block(intercept) | 0.75 | 0.866 |  | 0 | 0 |  |
| Fixed effects | Est | SE | Pr (>|z|) | Est | SE | Pr (>|z|) |
| intercept | 0.926 | 0.588 | 0.115 | 1.253 | 0.472 | **0.008** |
| treatment IBare | -2.639 | 1.035 | **0.011** | -2.639 | 1.173 | **0.024** |
| Treatment Cut | -2.639 | 1.035 | **0.011** | -0.693 | 0.72 | 0.335 |
| Treatment Long | NA | NA | NA | 0.305 | 0.654 | 0.64 |
|  |
| Multiple Comparisons of Means: Tukey Contrasts |
|  | Est | SE | Pr (>|z|) | Est | SE | Pr (>|z|) |
| IBare-Bare==0 | -2.639 | 1.035 | **0.028** | NA | NA | NA |
| Cut-Bare==0 | -2.639 | 1.035 | **0.028** | NA | NA | NA |
| Long-IBare==0 | NA | NA | NA | 2.94 | 1.165 | 0.053 |

a Bare = reference category; plots maintained bare (bare at the time of sowing, kept weeded and trimmed throughout the experiment); IBare = plots initially bare (bare at the time of sowing, but not weeded or trimmed thereafter); Cut = vegetation in plots cut to ~ 4cm at the time of sowing, but not trimmed again; Long = seeds sown in plots with unmanipulated vegetation; NA= 0% survivability; data removed from model.

**Table S5**. Generalised linear mixed model summary (negative binomial (NB) and Poisson) for seedling survivability (percentage of 100 seeds sown that established as seedlings) at Treeline site 10 and 104 weeks after sowing. P-values in bold are significant at α=0.001.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Wk 10 NB model** |  |  |  |  |
| Random effects | VAR | SD |  |
| block(intercept) | 3.01E-11 | 5.49E-06 |  |
| Fixed effects | Est | SE | Pr (>|z|) |
| intercept | 2.398 | 0.341 | **<0.001** |
| treatment IBarea | 0.327 | 0.475 | 0.492 |
| Treatment Cut | -0.35 | 0.492 | 0.476 |
| Treatment Long | -0.452 | 0.495 | 0.361 |
| **Wk 104 Poisson model** |  |  |  |  |  |  |
| Random effects | VAR | SD |  |  |  |  |  |
| block(intercept) | 0.008 | 0.092 |  |  |  |  |  |
| Fixed effects | Est | SE | Pr (>|z|) |  |  |  |  |
| intercept | 0.51 | 0.451 | 0.258 |  |  |  |  |
| treatment IBare | -29.8 | 1.33e+06 | 1 |  |  |  |  |
| Treatment Cut | -0.802 | 0.732 | 0.273 |  |  |  |  |
| Treatment Long | -49.65 | 3.88e+07 | 1 |  |  |  |  |

a Bare = reference category; plots maintained bare (bare at the time of sowing, kept weeded and trimmed throughout the experiment);IBare = plots initially bare (bare at the time of sowing, but not weeded or trimmed thereafter); Cut = vegetation in plots cut to ~ 4cm at the time of sowing, but not trimmed again; Long = seeds sown in plots with unmanipulated vegetation; NA= 0% survivability; data removed from model.