## GENERAL INFORMATION

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## ABSTRACT

The nutrient concentration in seeds determines many aspects of potential success of the sexual reproductive phase of plants, including the seed predation probability, efficiency of seed dispersal and seedling performance. Despite considerable research interest in latitudinal gradients of foliar nutrients, a similar gradient for seeds remains unexplored. We investigated a potential latitudinal gradient in seed nutrient concentrations within the widespread European understorey forest herb *Anemone nemorosa* L. We sampled seeds of *A. nemorosa* in 15 populations along a 1900-km long latitudinal gradient at three to seven seed collection dates post-anthesis and investigated the relative effects of growing degree-hours >5 °C, soil characteristics and latitude on seed nutrient concentrations. Seed nitrogen, nitrogen: phosphorus ratio and calcium concentration decreased towards northern latitudes, while carbon:nitrogen ratios increased. When taking differences in growing degree hours and measured soil characteristics into account and only considering the most mature seeds, the latitudinal decline remained particularly significant for seed nitrogen concentration. We argue that the decline in seed nitrogen concentration can be attributed to northward decreasing seed provisioning due to lower soil nitrogen availability or greater investment in clonal reproduction. This pattern may have large implications for the reproductive performance of this forest herb as the degree of seed provisioning ultimately co-determines seedling survival and reproductive success.

## MATERIALS & METHODS

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| **study area** | 5l (seed collection) |
| **time period** | 2009 |
| **goal** | Answer the two research questions:<br>- Is there a latitudinal gradient in seed nutrient concentration and stoichiometry of *Anemone nemorosa*?<br>- What is the relative importance of growing degree-hours, soil characteristics and latitude on seed nutrient concentration and stoichiometry? |
| **set-up** | 8 regions, 1900 km latitudinal gradient<br>2 populations per region (1 in northern Sweden) |
| **data collection** | seeds |

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| | - 3-7 sampling dates<br>- at every collection date: pooled seeds of 15–20 randomly chosen ramets per population<br>- mean dry seed mass; germination percentage; content of C, N, P, K, Ca, Mg; alkaloids for the northern- and southernmost provenances<br>environmental variables<br>- number of growing degree hours above 5°C<br>- latitude<br>- soil cores (0-4 cm): pH, P, K, Ca, Mg, C, N (in 2008 or 2009) |
| **remarks** | |

## RESULTS

Seed N and N:P ratio were significantly negatively related to latitude, whereas the seed C:N ratio increased with increasing latitude. When all seed collection dates were considered, seed Ca was negatively related to latitude. When considering only the last collection date in every population (i.e., the most mature seeds), the strength of the relationships with latitude increased. The other seed nutrient concentrations showed no significant latitudinal cline.

| mean (±SE) across all collection dates | N-France | N-Sweden |
|---|---|---|
| seed N (%) | 3.33 ± 0.22 | 2.52 ± 0.07 |
| seed N/P | 8.4 ± 0.5 | 6.5 ± 0.2 |
| seed C/N | 15.4 ± 0.8 | 20.1 ± 0.6 |
| seed Ca (ppm) | 5245 ± 450 | 3502 ± 607 |

Soil conditions consistently affected seed C and seed N:P ratio, while positive effects on germination and negative effects on seed Ca were apparent only when all or only the last collection date was considered, respectively. In the TLC analysis, no alkaloids were found in any of the seed lots with extreme total N concentration (i.e., northernmost and southernmost seed provenances).

Furthermore, all seed traits of *Anemone nemorosa* were affected by the seed collection date. For example, the earliest collected seeds with the lowest degree-hours failed to germinate whereas seeds collected later showed germination rates up to 94%. Overall, germination percentages were positively affected by seed mass, seed C and N as well as seed N:P ratio but negatively affected by seed K, Ca and Mg concentrations. Seed mass and seed C showed a threshold effect and a clear correlation with germination percentage. This pattern was independent of the climatic zone where the seeds were collected.