Growth and mineral nutrition of Dutch Taraxacum taxa from fertile and infertile sites

Hommels, Cornelis Hendrikus

Summary

Fieldstudies, conducted by workers of the 'Vakgroep Bijzondere Plantkunde' (University of Amsterdam) revealed marked differences in soil preference as regards levels of mineral nutrition between Dutch Taraxacum taxa. This thesis aimed to explain in physiological terms this variation in mineral habitats between Taraxacum taxa. Several lines of investigations were pursued resulting in the description and comparison of a rather wide range of physiological traits. As typical representatives for taxa from fertile and infertile sites, respectively, T. sellandii and T. nordstedtii were used in all experiments. Occasionally, the number of taxa studied was increased (up to 12), with (other) taxa derived from euthrophic, mesothrophic and oligothrophic habitats.

In Chapter 2, recovery from mineral deficiency was studied including restored growth and mineral accumulation after an ample mineral replenishment: the results showed an (almost) absence of differences between T. sellandii and T. nordstedtii.

Differences in morphological and physiological plasticity between a number of Taraxacum taxa are presented in Chapter 3. Compared with truly plastic plants as some so called 'anticipatory' Plantago taxa, all Taraxacum taxa studied responsed rather rigidly to a change in mineral nutrition as far as growth, root respiration and activity of Mg^{2+}-ATPase of the microsomal fraction of the roots are concerned. The small responses that did occur within the period directly following the nutrient change correlated with the mineral ecology of the habitats. Consequently, the method of changing the mineral condition provided a simple diagnostic tool to determine the adaptation of the various taxa to the mineral habitat.

A possible physiological explanation for the absence or presence of specific taxa at fertile sites was obtained by studying Taraxacum plants cultured at (near) optimal conditions (Chapter 4): the growth potential of taxa from fertile sites exceeded that of taxa from less fertile sites. This difference was most markedly during the early stage of vegetative growth. The fast-growing taxa were characterized by a productive C-allocation into the shoot (i.e. high shoot-root ratio), and the development of a flat and dense leaf rosette. These features probably ensured a sufficient utilization of scarce light and space. In contrast, slow-growing microspecies showed a less prominent above-ground presence, due to a low shoot-root ratio and/or a low specific leaf area.

The physiological explanation for the absence or presence of specific taxa at infertile sites was first studied on T. sellandii and T. nordstedtii (Chapter 5). Parameters such as the critical nutrient concentration (i.e. the minimal internal mineral concentration associated with undisturbed growth) of N, P, and K^+, and the efficiency in N, P, and K^+ use were determined. The most pronounced difference between these two microspecies concerned the critical K^+ concentration, the value for T. sellandii being twice as high as that for T. nordstedtii. This result showed the phenomenon of 'trade-off': the physiological trait that enabled T. sellandii to attain a high growth potential (i.e. a productive C-allocation), simultaneously caused an increased

vulnerability to K^+ deficiency. Considering the results as regards critical nutrient concentrations, preservation of P_i-uptake at P-deficiency and P_i-accumulation after P_i replenishment following P-deficiency, luxury consumption of P_i and K^+, and N- and (possibly) P-use efficiency at deficient N- and P- internal concentrations, T. nordstedtii was better adapted to nutrient constraints than T. sellandii.

The results derived from a low nutrient flowing solution, using 9 taxa, confirmed the above statement (Chapter 6). T. nordstedtii showed a superior growth, compared with T. sellandii. Other taxa from fertile sites closely resembled the stunted growth of T. sellandii. There was a broad group of taxa, derived from mesothrophic to oligothrophic habitats, that showed intermediate growth. The course of efficiency in N-use, presented as a function of internal N concentration, showed that T. sellandii was slightly superior at high internal N-levels, that T. nordstedtii was clearly superior at intermediate internal N-levels, and that differences disappeared at conditions of severe N-stress.

As a consequence of the results, demonstrating the importance of K^+ ions in the attainment of a high growth potential in Taraxacum plants, $K^+(Rb^+)$-uptake kinetics of whole plants was studied (Chapter 7). An introductionary study showed that the mechanism of Rb^+-uptake depended on the mineral status (i.e. the pretreatment applied to the plants) of the plants. A comparitive study on Rb^+-uptake kinetics of $CaSO_4$-pretreated plants provided evidence for a 'velocity' strategy within the taxa studied: taxa from fertile sites showed a high K^+ (System I) uptake rate. The uptake rate of T. nordstedtii could be distinguished from all other (11) taxa studied. There was no clear evidence for a K^+ 'affinity' strategy, i.e. a low K_m in plants from mineral-poor habitats, In view of the limited significance of K^+ for growth at infertile sites, this was not unexpected.