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The Effect of Local and Widespread Nutrient Supply on Growth and Development of *Potentilla reptans* L.

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Abstract: The functional organization of the clonal plant of *Potentilla reptans* L. in terms of the distribution of localized and widespread nutrient supplied to non-supplied rooted ramets and unrooted ramets of the clone was investigated. Observations were made on leaf and branch production of rooted ramets and unrooted main stolon of the clone. The dry weight of the component of clone was also recorded. There was a very localized response to nutrient supply with the growth response largely restricted to nutrient supplied ramet and to the unrooted main stolon where the nutrient supplied ramet was in adjacent position. However, it was noted that very severe symptoms of nutrient deficiency gradually appeared in ramets deprived of nutrients and presumably would eventually die with time. Ramets supplied with nutrients showed a significantly greater production of leaves and branch ramet and dry weight. Nutrient movement with the stolon axis is therefore distinctly acropetal to the exploratory growth of the stolon and is maintained of the older ramets which with time must senesce and die.

Key words: Main stolon, functional organization, localized, *Potentilla reptans* L.

Introduction
Most soil types provide sufficient mineral nutrients for plant growth but some may have a low content of a particular nutrient leading to characteristic nutrient deficiency symptoms of plant. Such symptoms can be induced readily in sand or water culture by omitting the element from the nutrient solution, and each element tends to induce a characteristic set of deficiency symptoms. For nitrogen, deficiency symptoms consist of a general yellowing (chlorosis) of the older leaves and this is accompanied by very restricted growth. Young leaves remain green as they are supplied with organic forms of N by retranslocation from senescing leaves (Salisbury and Ross, 1978).

One of the main characteristics of the soil environment is the heterogeneity in nutrient content over a very small scale (Lechowicz and Bell, 1991; Jackson and Caldwell, 1993; Robertson and Gross, 1994). For example, Jackson and Caldwell (1993) found that nitrate and ammonium concentration in the soil of a cold desert habitat varied more than tenfold at a scale of 50 cm, and that there was still a threefold variation at a scale of 3 cm. Neighbouring ramets of stoloniferous and rhizomatous plants may therefore become established at sites of quite contrasting resource supply. Experimental studies in the field and glasshouse have investigated this prospect by following the long-term growth response to local application of nutrients. Studies have been centered on whether the response is expressed just locally or whether it is more widespread (Noble and Marshall, 1983; Evans, 1988 and 1991; Marshall and Anderson-Taylor, 1992;

Wijesinghe and Handel, 1994; Birch and Hutchings, 1994, and Jonsdottir and Watson, 1997). Virtually in all the cases mineral nutrients move relatively freely from old ramets situated in resource-rich sites to younger ramets in resource-poor sites, i.e. the transfer is acropetal. This is also associated with local proliferation of the resource-rich ramets (Birch and Hutchings, 1994, and Wijesinghe and Handel, 1994). This experiment was conducted to examine the effect of enhanced local nutrient supply to individual ramets on the growth and development of the clonal system of *P. reptans*. In previous experiments with *A. stolonifera* Marshall and Anderson-Taylor (1992) found that stolons displayed independent nutrient economies but that there was some degree of integration within an individual stolon, with unrooted tiller ramets performing better than tiller ramets that were rooted and only supplied with water. This aspect is investigated further in this experiment.

Materials and Methods
The experiment was conducted in the Pen-y-ffridd Field Station of the University of Wales Bangor, (UK) during March 1996. in glasshouse with minimum day and night temperature of 20 and 14°C respectively, and with natural daylight supplemented by 400W sodium vapour lamps to give a minimum photoperiod of 14h.

The plants of *Potentilla reptans* L. were maintained in trays of John Innes No.1. potting compost under glasshouse conditions by regular vegetative propagation. The second youngest node from the apex of a stolon was rooted by pinning it to the
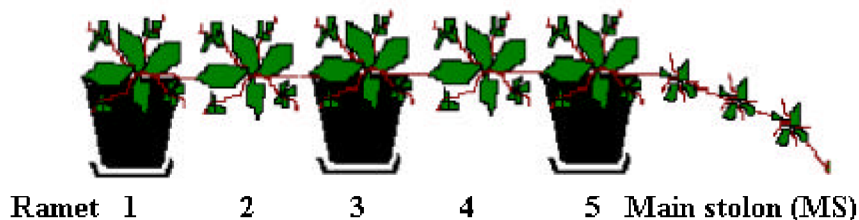

Ramet 1   2   3   4   5   Main stolon (MS)

Table 1: Experimental treatments T1-T4 as fallow: Ramet 1 (R1), R3 and R5 are rooted ramets and R2 & R4 are unrooted R1 is the oldest ramet of the main stolon.

Treatments:

Treatments			
T1	: 100% nutrients	water	water
T2	: water	100% nutrients	water
T3	: water	water	100% nutrients
T4	: 33% nutrients	33% nutrients	33% nutrients

surface of a 9-cm² square pot containing sand. This node was classed as node one and it gave rise to ramet 1 (R1). Similarly R3 and R5 were rooted in sand by the same stolon. After producing roots, four nutrient treatments (T1-T4) were applied each with four replicates. Ramet 1, 3 & 5 were supplied full strength (100%) in (T1-T3) respectively, and in T4 (33%) one third of full strength to R1, R3 & R5 (see Table 1). These treatments were based on the Long Ashton solution (Hewitt, 1966) and were supplied as full strength (100%) or one third of full strength (33%). Hundred ml of these solutions or water were applied to ramets every 2 days for 28 days. Saucers were placed under all pots to localize the nutrient treatments. The number of leaves, stolon branches of the rooted ramets (R1, R3 & R5) and main stolon (MS) length were recorded every four days for 28 days. The biomass of these components of the clone was also recorded at 28 days after oven drying at 70 °C. The statistical analysis was performed using ANOVA (Anonymous, 1993), the comparison of means was made by Tukey's honestly significance difference (HSD) test at P≤0.05.

Results

The overall production of leaves and branches of R1, R3, R5 and MS showed significant differences between treatments (Fig. 1 & 2). Leaf and branch production of R1 was significantly greater in T1 and T4 as compared to T2 and T3 (Fig. 1a & b). In R3 the production of leaves and branches was significantly greater in T2 and T4 than T1 and T3 (Fig. 1c & d). In the case of R5 and MS the production of leaves, and branches was significantly greater in T3 and T4 as compared to T1 and T2 (Fig. 2a-d).

The biomass of branches and leaves of R1 was significantly greater in T1 than in the other treatments, and for leaves T4 produced significantly greater dry weight than both T2 and T3 (Fig. 3a & b). In case of R3, T2 and T4 produced significantly greater branches and leaf dry weight than T1 and T3 (Fig. 3c & d). The production of leaves and branches of R5 and MS was significantly greater in T3 and T4 than in T1 and T2, but T4 produced significantly less branch dry weight than T3 (Fig. 4a-d). In R3, T2 was significantly greater than the other
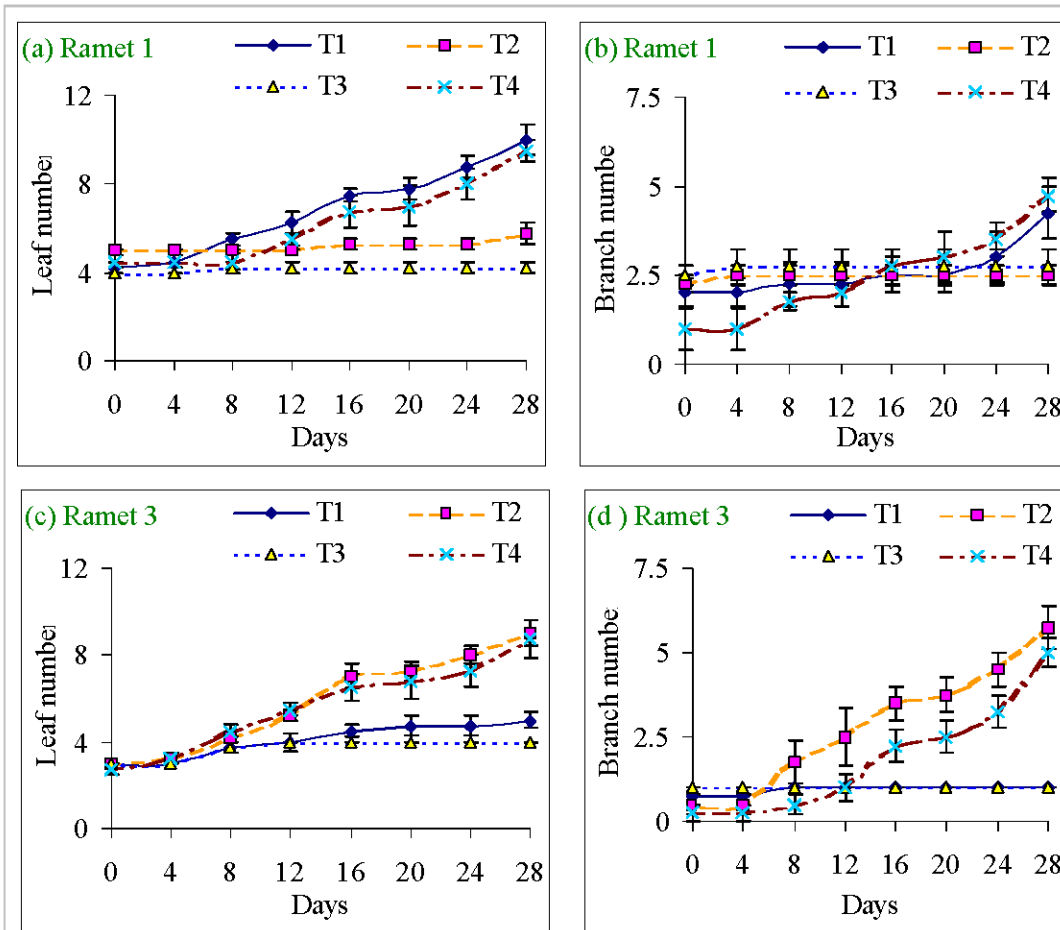

Fig. 1: The effect of local nutrient supply on leaf number (a and c), branch number (b and d) with time in R1 and R3. Bars represent ±SE.
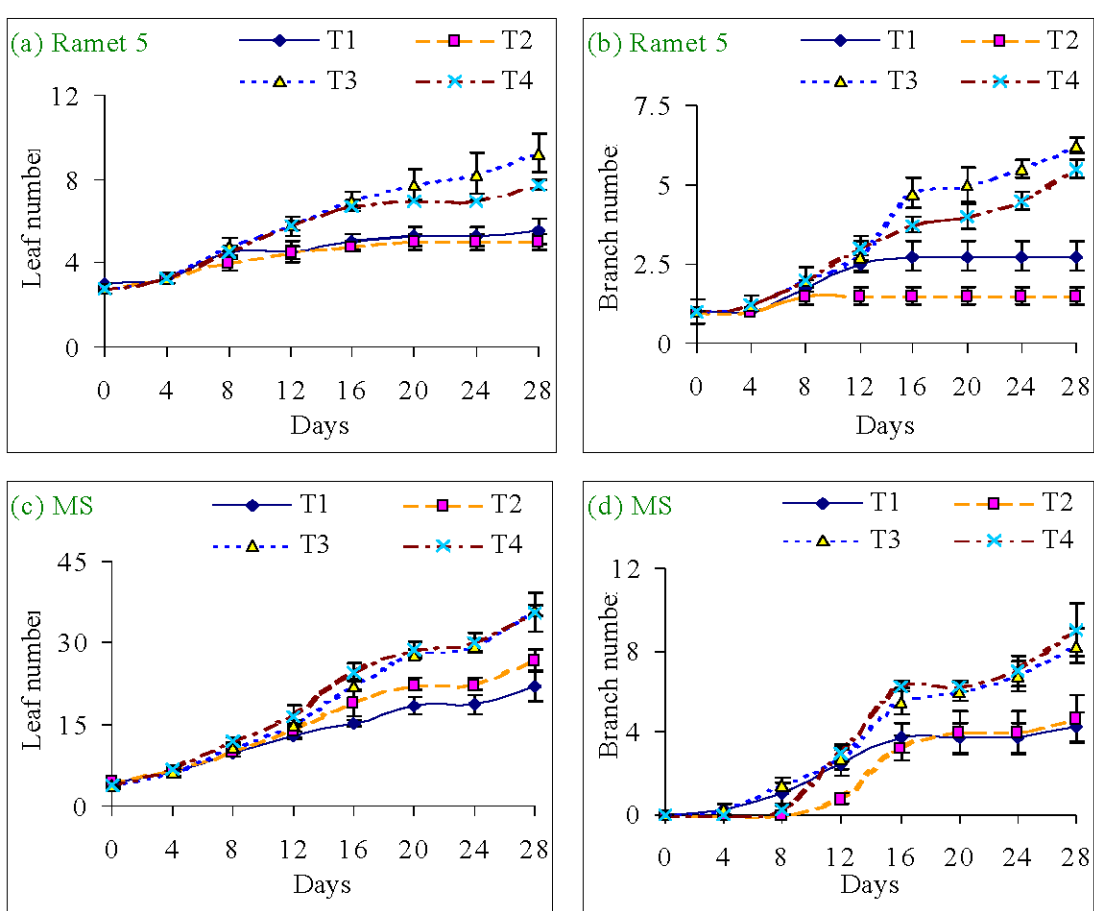
Fig. 2: The effect of local nutrient supply on leaf number (a and c), branch number (b and d) with time in R5 and MS. Bars represent ±S.E.

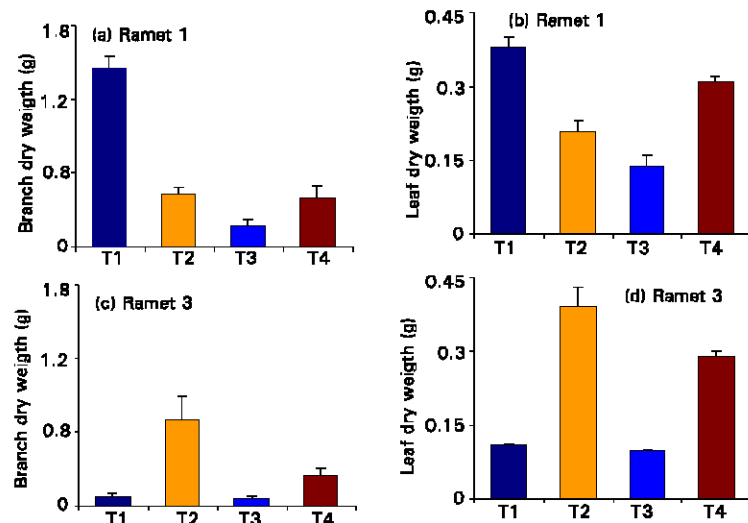Fig. 3: The effect of local nutrient supply on biomass of branches (a and c) and leaves (b and d) of R1 and R3. Bars represent ± S.E.
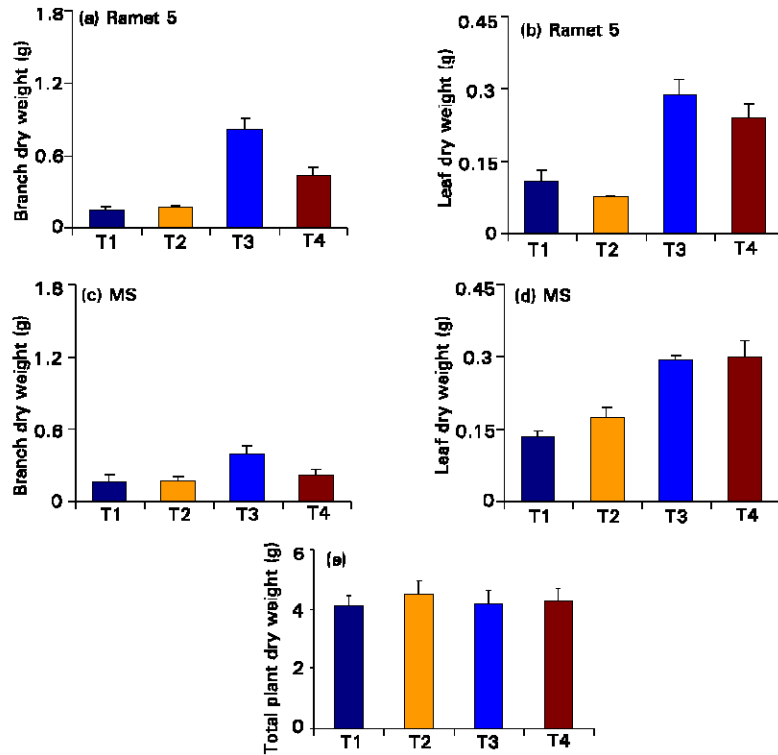
Fig. 4: The effect of local nutrient supply on biomass of branches (a and c) and leaves (b and d) of R5 and MS and (e) total plant dry weight. Bars represent ± S.E.
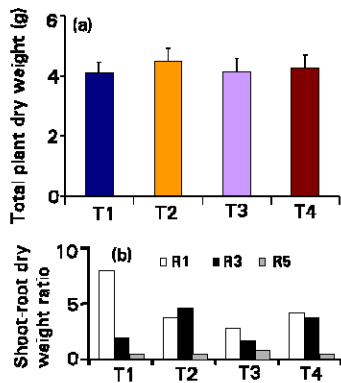

Fig. 5: The effect of local nutrient supply on total plant dry weight (a) and shoot-root dry weight ratio (b). Bars represent ± S.E.

treatments, and in R5 both T3 and T4 were significantly greater than T1 and T2 with T4 having significantly less dry weight than T3 (Fig. 3c & d and Fig. 4a & b). There was no significant difference between the treatments with respect to total plant dry weight (Fig. 4e).

Discussion

Overall the results of this experiments showed that the locally nutrient supplied ramets did not share to any major extent their nutrients with their neighbouring ramets, even though the latter were rooted in sub-optimal nutrient conditions or were unrooted. As a result the growth of the nutrient supplied ramets was generally promoted, whereas that of the other ramets was very restricted. In this experiment there was also some evidence, particularly for the unrooted R4, of improved performance when R3, the older neighbouring ramet, was supplied with 100% nutrients. The performance of R4 was however not affected by nutrient addition to R5, the younger neighbouring ramet.

The total biomass of the entire clone at the final harvest was not significantly different between any of the treatments, a longer time period may be needed for differences to be expressed.

This overall response supports the results obtained for *A. stolonifera* and for other species from similar experiments (Marshall and Anderson-Taylor, 1992; Wijesinghe and Handel, 1994; Hutchings and Wijesinghe, 1997). Thus the nutrient economy of ramets tends to be independent and the support of other parts of the stolon is virtually restricted to the unrooted extending main stolon component, but this is only affected when the nutrient supplied ramet is adjacent to the extending main stolon. Nutrient movement with the stolon axis is therefore distinctly acropetal to the youngest regions of the stolon. In this way the exploratory growth of the stolon is maintained at the expense of the maintenance of the older ramets which with time must senesce and die. This interpretation is supported by the results of experiments that have followed the movement of radio tracers and dyes where there is strict acropetal distribution (Headley *et al.*, 1988; Marshall, 1990; Jonsdottir and Callaghan, 1990; Price and Hutchings, 1992, and Price *et al.*, 1992), although in some cases nutrients move throughout the entire stolon or rhizome. Only extreme situations, such as the imposition of severe

water stress, results in any significant basipetal flow of nutrients (Marshall, 1990).

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