Changes Of Dry Matter, Nitrogen Content And Nitrogen Efficiency In Oilseed Rape (Brassica napus L.) In Relation To Nitrogen Nutrition

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Introduction

Oilseed rape is a crop with a high nitrogen requirement (Holmes 1980). There is a large effect of nitrogen supply on nitrogen uptake. Lefevre and Lefevre (1957) described that nitrogen uptake is highest at the rosette stage and main stem elongation growth. Allen and Morgan (1972, 1975), Allen et al. (1971) and Scott et al. (1973) published the influence of an different nitrogen supply on the development of oilseed rape. The effect of a different N-nutrition on the leaf growth is described by Ogunlela et al. (1989).

There are only few informations about nitrogen efficiency in relation to N-supply (Holmes 1980). This experiment was conducted to study the changes in dry matter accumulation, nitrogen concentrations and nitrogen efficiency of single rape organs and the total rape plants in relation to N-supply.

Materials and Methods

The summer rape plants were grown in a hydroponic system under controlled conditions with $20^{o}/15^{o}$C day/night temperatures and at the first growth stage a 12-h photoperiod and 80 W/m^2 illumination additional to the daylight. Rape plants grown up in 5 L plastic pots. The solution was aerated continuously. The nutrient solution was a modified Hoagland solution which was replaced weekly. Treatment in this experiment were three levels of nitrogen (2, 7 and 12 mM N) given as NH_4NO_3. With transplanting the rape plants into the hydroponic pots plants were harvested in the first growth stages every 7 days later in longer distances. Six plants per N-level were harvested at all harvest dates. The plants were dissected into different organs (root, main stem + axillary branches, leaves, hulls and seeds). Sample were oven dried. After the estimation of the dry weights sample were ground. Nitrogen content was analysed by the Kjeldahl procedure in the presence of selenium reagent as catalyst. Other details regarding nutrient solution and experimental set-up were described by Kullmann et al. (1989) and Ogunlela et al. (1990).

Results

The increase of total dry matter (TDM) decreased with higher N-levels (Table 1). The part of the root of total dry matter decreased when the N nutrition increased from 2 mM N up to 7 mM N. Between 7 and 12 mM N there was no differences. The portion of stem increased with higher N-levels from 28% (2mM N) up to 39% (12 mM N). The leaves decreased only between 2 and 7 mM N. There are no effects on the percentage of the hull dry weight. Seed dry matter increased with a higher N-nutrition in relation to the total plant weight.

Table 1. Total dry matter (g) per plant and dry matter relations of some plant organs (TDM = 100%) in relation to N-supply

N-supply (mM N)	TDM(g)	% of total dry matter root	stem	leaves	hulls	seeds
2	57.14	14.98	27.79	13.77	24.07	19.43
7	106.26	7.45	32.18	18.85	24.96	16.56
12	136.45	8.31	38.84	18.96	24.26	9.64

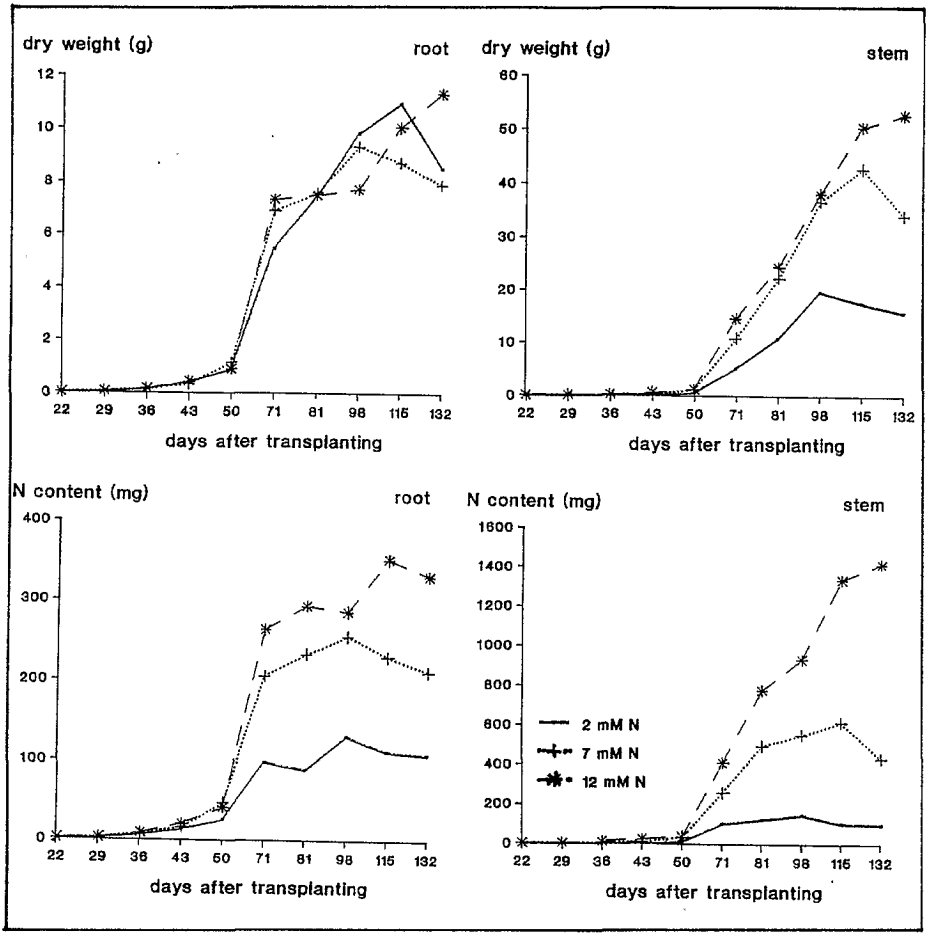

Fig. 1. Dry weights and nitrogen contents of root and stem over a total growth period

Dry weights and nitrogen contents of root, stem leaves and pods are described in figure 1 and figure 2. The development of the root dry matter show that the maximum is reached at different growth times in relation to N-supply. The root dry weights have an decrease in the

late growth period growing up under the first two N-levels. The differences between these two treatments are not great. The root dry weight of the plant growing up under the highest N-level did not reach a maximum. The N content of these three treatments show a clear graduation.

The dry weight and nitrogen content development of the stems were reached at different times. The absolute dry weights and nitrogen contents increased in relation to the N nutrition.

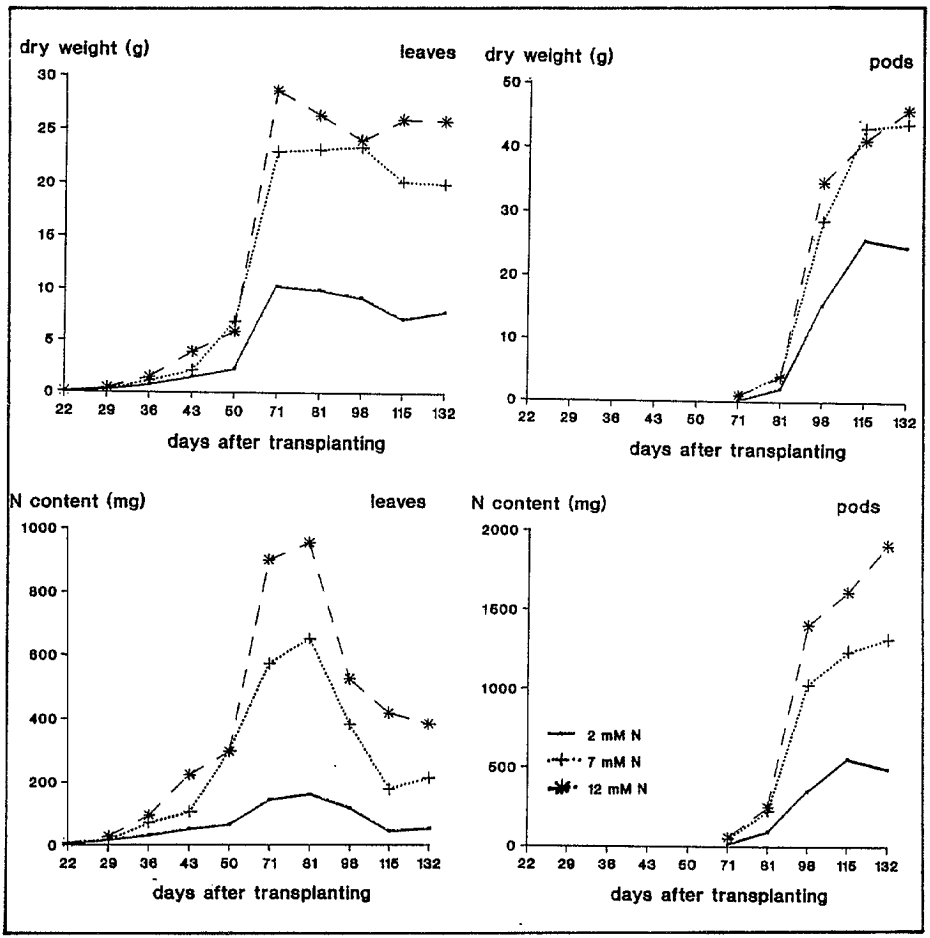

Fig. 2. Dry weights and nitrogen contents of leaves and pods over a total growth period

The dry weights of the leaves reached different maximum values in relation to N supply. The maximum dry matter was reached seventy days after transplanting the rape plants. Some days later the nitrogen content decreased within all nitrogen levels. The pods grown up

under 7 and 12 mM N have only a little difference in dry weights. The nitrogen content of the pods show the dependence to the nitrogen treatments.

The translocated nitrogen out of senescent plant organs , calculated as highest nitrogen content minus nitrogen content at the end of the growth period, is shown in table 2. Root, stem and hulls translocated more nitrogen if when the nitrogen supply increased from 2 up to 7 mM N. When we have a nitrogen supply of 12 mM N we found no nitrogen translocation. The content of translocated nitrogen out of the leaves increased in relation to N-supply. The seeds translocated no nitrogen.

Table 2. Translocated nitrogen (mg) out of senescent plant organs in relation to N-nutrition

N-supply (mM N)	translocated nitrogen (mg) root	stem	leaves	hulls	seeds
2	22.6	48.2	107.6	118.0	n.t.
7	42.9	116.8	435.3	368.8	n.t.
12	n.t.	n.t.	n.t.	n.t.	n.t.

n.t. = no translocation

In table 3 we calculated the absolute translocated nitrogen content in relation to the highest nitrogen content of the plant organ. These data give informations about the role of these plants parts in later growth stages as nitrogen pools which can used from growing plant parts like pods. The leaves translocated 66% of the nitrogen into other plant parts when plants were growing under a nitrogen level of 2 or 7 mM N. If we have higher N-levels the amount of translocated nitrogen decreased. Nitrogen translocation out of roots, stems and hulls decreased when the nitrogen supply increased from 2 up to 7 mM N. With 12 mM N there was no translocation.

Table 3. Nitrogen content (%) translocated out of senescent plant organs (highest N-content during growth period = 100%)

N-supply (mM N)	translocated nitrogen content (%) root	stem	leaves	hulls
2	17.3	32.8	66.4	58.2
7	16.8	21.1	66.9	47.5
12	n.t.	n.t.	59.7	n.t.

n.t. = no translocation

The harvest index calculated as the relation pod dry weight in percentage of total plant dry matter and the nitrogen harvest index calculated as the relation pod nitrogen content in percentage of the total plant nitrogen content are described in table 4.

Table 4. Harvest index and nitrogen harvest index in relation to N supply

N-supply (mM N)	HIP	NHIP
2	0.44	0.61
7	0.41	0.61
12	0.34	0.47

HIP = harvest index for pods
NHIP = nitrogen harvest index for pods

The results show no differences between the first two N levels. HI and NHI decreased with higher N nutrition.

Discussion

A different nitrogen nutrition has some effects on the plant developments and the development of single plant organs. With an higher N-supply plant reach the maximum of dry weight later than plants growing up with a low N level. The translocation of nitrogen decreased with an increase of nitrogen concentration in the hydroponic solution. With 12 mM N most of plant organs translocated no nitrogen. The harvest index is one possibility to describe the efficiency of the pod dry matter accumulation. These pods are the most interesting yield components of rape plants. With the nitrogen harvest index we describe the efficiency of nitrogen for the yield components. There are no differences between 2 and 7 mM N but a decrease if the plants grow up with 12 mM N. The percentage of translocated nitrogen out of senescent plant organs decreased with an increase of the nitrogen concentration. This is one way to describe the importance of different senescent plant organs for the yield building.

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