GROWTH AND DISTRIBUTION OF THE ROOT SYSTEM IN BRASSICA NAPUS

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INTRODUCTION

In a series of field experiments, started in 1987, above-ground growth analysis of different Brassica crops was carried out within an Indo-Swedish collaborative research programme on rapeseed/mustard improvement. In one of the species, B. napus, the root system also was studied.
The purpose of the investigations was to find a methodology to describe the rooting pattern, and to relate the growth and distribution of the root system to above-ground development and the weather conditions.
This paper will mainly present the results from the root samplings in one year only, 1987.

MATERIAL AND METHODS

In the field, Brassica napus L. cv. Hanna, was grown at the Swedish University of Agricultural Sciences (59° N, 17° E) with 12 cm row spacing and a plant density of about 150 plants per m^2 in three replications.
Fertilizer was applied at sowing (May 4); nitrogen 90 kg per ha, phosphorus 30 kg per ha and potassium 30 kg per ha.
The soil was a postglacial clay (5% sand, 59% silt, 37% clay) with 0.16% total nitrogen, 1.39% organic carbon and a pH value of 6.7. Three horizons were identified; plough layer A (0-23 cm), subsoil B 1 (23-65 cm) and B 2 (65-100 cm).

Above-ground plants were sampled at least once a week from emergence to maturity.
The root system was sampled six times, from the onset of growth until the total dry matter in the profile started to decline. At each sampling time, four soil cores (diameter 55 mm) per replication were taken to 1 m depth. The samples were pooled (horizons kept separate) and roots washed by a hydropneumatic elutriation system (Smucker et al., 1982). Dry weight was measured and total root length was determined using a root length scanner (COMAIR, Australia) for each horizon. Mean root radius (taproot excluded) was calculated, as well as surface area assuming a cylindrical stereometry of the roots.
Root parameters are expressed on an area basis. The numerical value for a given parameter will be the same whether expressed on an area or volume basis if the whole profile (0-100 cm) is considered, but not when studying the different horizons.

RESULTS AND DISCUSSION

The 1987 growing season was rainy and cool. Precipitation for the whole growing period, May-September, was 20% higher than normal (322 mm), and mean monthly temperature was lower than normal for all five months.
Above-ground, the development of the crop (Fig. 1) from emergence to seed maturity required 113 days, with an accumulated temperature sum of 904 growing degree days (GDD) with +5 C used as a baseline temperature (Morrison et al., 1989). Onset of stem elongation was reached, on average, after 122 growing degree days (GDD) or 23 days after emergence, onset of flowering after 247 GDD or 38 days and end of flowering after 589 GDD or 70 days (Sylvester-Bradley & Makepeace, 1984).
Below-ground dry matter started to decrease at the end of the flowering stage of the crop, well before the decline in the above-ground dry matter. At the final root sampling, the shoot to root ratio was about 8:1.

Fig. 2 shows the development of root dry matter, root length, mean root radius as well as root surface area with time in the whole profile, 0-100 cm.
Dry matter, length and surface area all increased until the penultimate sampling, and decreased only between the two last samplings when the crop was in the end of the flowering stage.
Mean root radius increased rapidly between the first and second sampling, thereafter the roots became slightly thinner.
Maximum total profile root dry matter and length obtained in the cool, wet and long 1987 growing season were about 200 g/m^2 and 2 km/m^2 respectively.

Fig. 3 shows the development of the different root parameters in the three horizons.
Dry matter of the root system was found almost entirely in the 0-23 cm horizon. A maximum of about 15 per cent of the total root dry matter in the profile was found below 23 cm depth.
However, the decline in the total profile dry matter at the end of the sampling period took place only in the A horizon.
In the A horizon, total root length increased only until the second sampling and decreased sharply at the end of the season, the final value being only slightly larger than the original value.
When, as from the second sampling, total root length in the profile increased, the increase took place in the deeper horizons, especially the B 1 horizon. At the last sampling, only about 30 per cent of the profile's total root length was found in the uppermost horizon.
Roots in the A horizon were thicker than roots in the deeper horizons, and grew thicker and thicker with time. Mean root radius in the A horizon was almost 0.7 mm at the last sampling, in the B 1 and B 2 horizons about 0.3 mm.
It is clear that root length was more homogeneously distributed in the profile than root dry matter. Roots were present in all three horizons at the end of the sampling period, although roots found in the two deeper horizons were much thinner than roots in the topsoil.
Surface area, i.e. the total contact area between the root system and the surrounding soil, is of great importance for nutrient and water uptake from the soil. As for root length, which is used when calculating surface area, the surface area of the root system is much more evenly distributed in the profile than dry matter.

Rooting depth, frontier as well as single roots, showed an almost linear relationship with time (Fig. 4).
Maximum depth of the root frontier was found to be about 45 cm, while single roots grew down to about 90 cm.
Root elongation, i.e. increase in depth of rooting of the frontier on an average over the whole sampling period of 53 days, was about 8 mm/day.

Of interest for further investigations is to relate root growth not only to temperature but also to soil water content. In 1987, the year presented in this paper, no water stress ocurred at any time during the growing season. Also, for a better understanding of shoot/root relations, root sampling has to continue throughout the whole growing season.

ACKNOWLEDGEMENT

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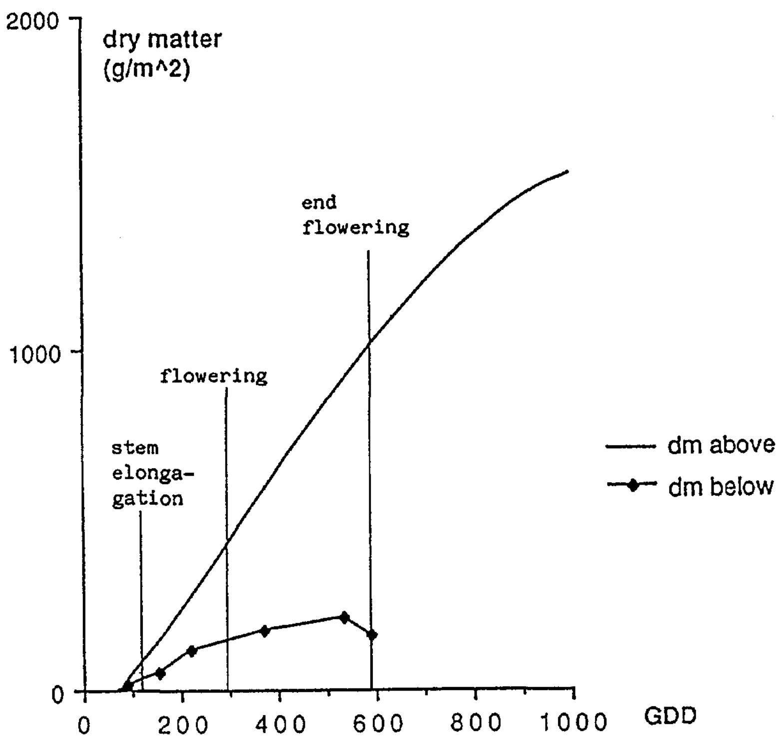

Fig. 1. Dry matter accumulation above- and below-ground.
GDD = Growing degree days (accumulated heat sum)

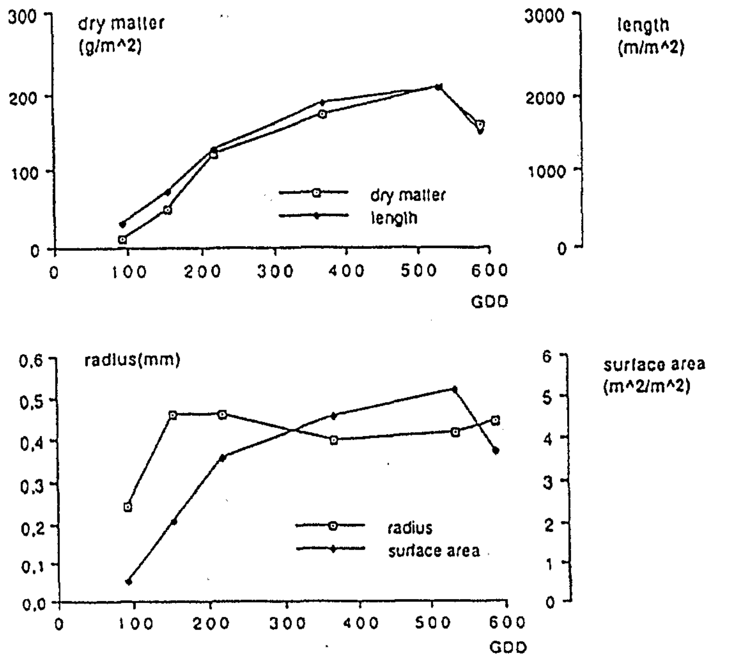

Fig. 2. Root dry matter, length, mean radius and surface area in the whole profile (0-100cm).

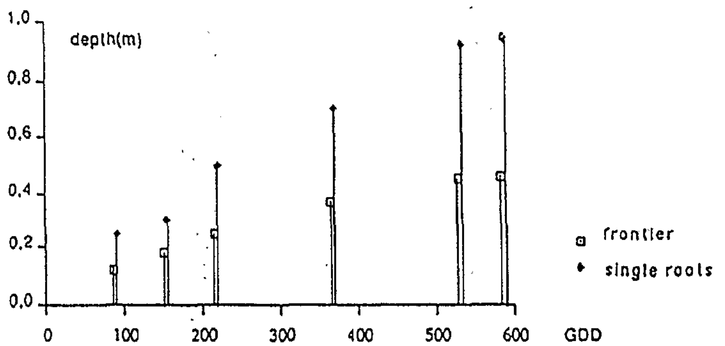

Fig. 4. Rooting depth of frontier and single roots.

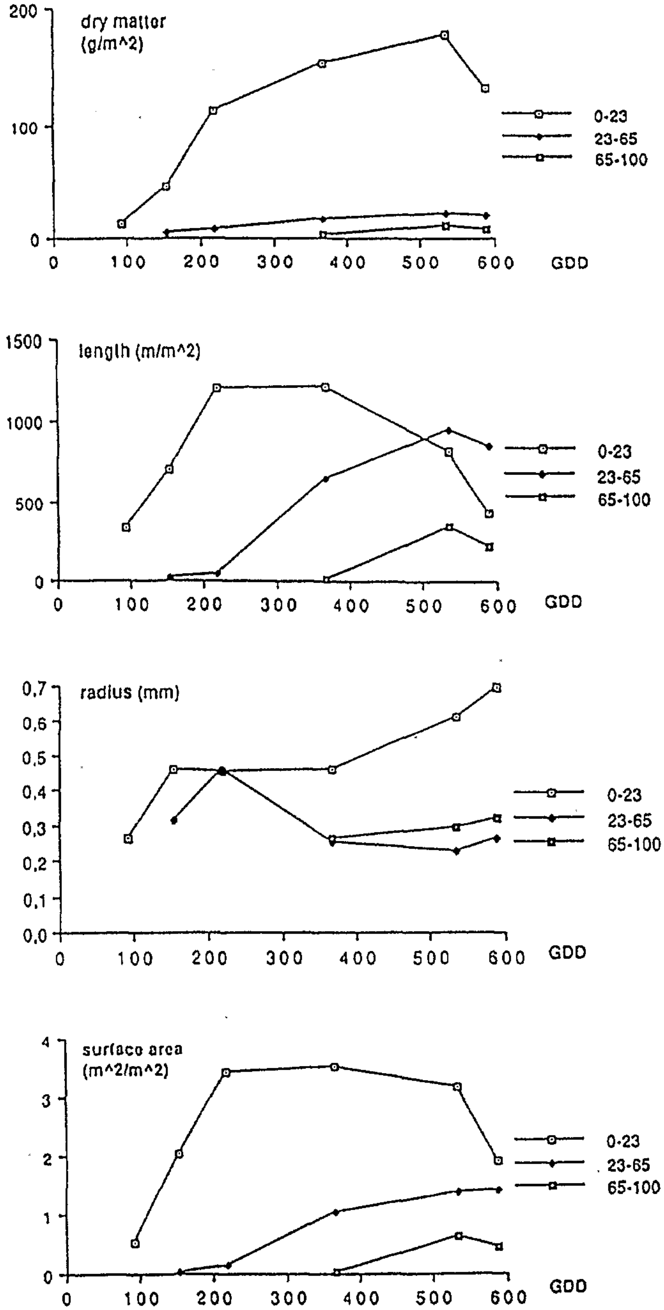

Fig. 3. Root dry matter, length, radius and surface area in the different horizons; A (0-23 cm), B1 (23-65 cm), B2 (65-100 cm).