51 Effect of Ammonium and Nitrate Nutrition on the Growth of Carob *(Ceratonia siliqua* L.) Plants

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Under natural conditions, nitrate and ammonium are the main forms of inorganic nitrogen brought about chiefly through the activities of nitrogen-fixing and nitrifying microorganisms. The physiological responses of plants to the ions is, however, very different and the ability of plants to absorb and/or metabolize them, varies greatly (Hewitt 1966).

Carob is a leguminous tree plant with great importance in the economy of Mediterranean countries due to the value of its products which constitute raw material for several important industries. This crop presents the inability to form an effective nitrogen-fixing symbiotic association (Grobbelaar and Clarke 1974; Martins-Loução 1985), though it can grow well without any special soil requirements.

Since we are deeply concerned about the influence of the processes occurring in the soil rhizosphere preparatory to the act of uptake by the root (presence or absence of free-living bacteria or mycorrhizae), we decided to investigate first the effect of different sources of nitrogen on carob growth under hydroponic culture conditions. The role of cotyledons on the growth of carob seedlings was also investigated by comparing the growth differences between plants with and without cotyledons.

Carob seeds were sown in wet, sterilized, expanded clay at 25° ± 2°C with a 12-h photoperiod. After 20 days of germination (Martins-Loução 1985), seedlings were transplanted to pots containing 3 liters of a nitrogen-free Crone nutrient medium (Bond 1951). The pots contained the following nitrogen supplements: (1) NO_3^- alone; (2) NH_4^+ alone; (3) a mixture of NO_3^- and NH_4^+, at a total nitrogen concentration of 50 mg l^{-1}. In all these treatments the seedlings, with or without cotyledons, were compared with others without nitrogen supplement. Every 8 days the solutions were changed to maintain nutrient concentrations. The plants were grown to 90 days in a controlled environment of a 12-h photoperiod (80–100 μE m^{-2} s^{-1}, provided by Philips Daylight 45 W), a temperature of 24° ± 4°C and a relative humidity of 60%.

At the harvest, height, root length, leaf area, dry weight, chlorophyll content, photosynthetic rate, and nitrogen content were estimated (Fig. 51.1).

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Inorganic Nitrogen Metabolism
Edited by Ullrich et al.

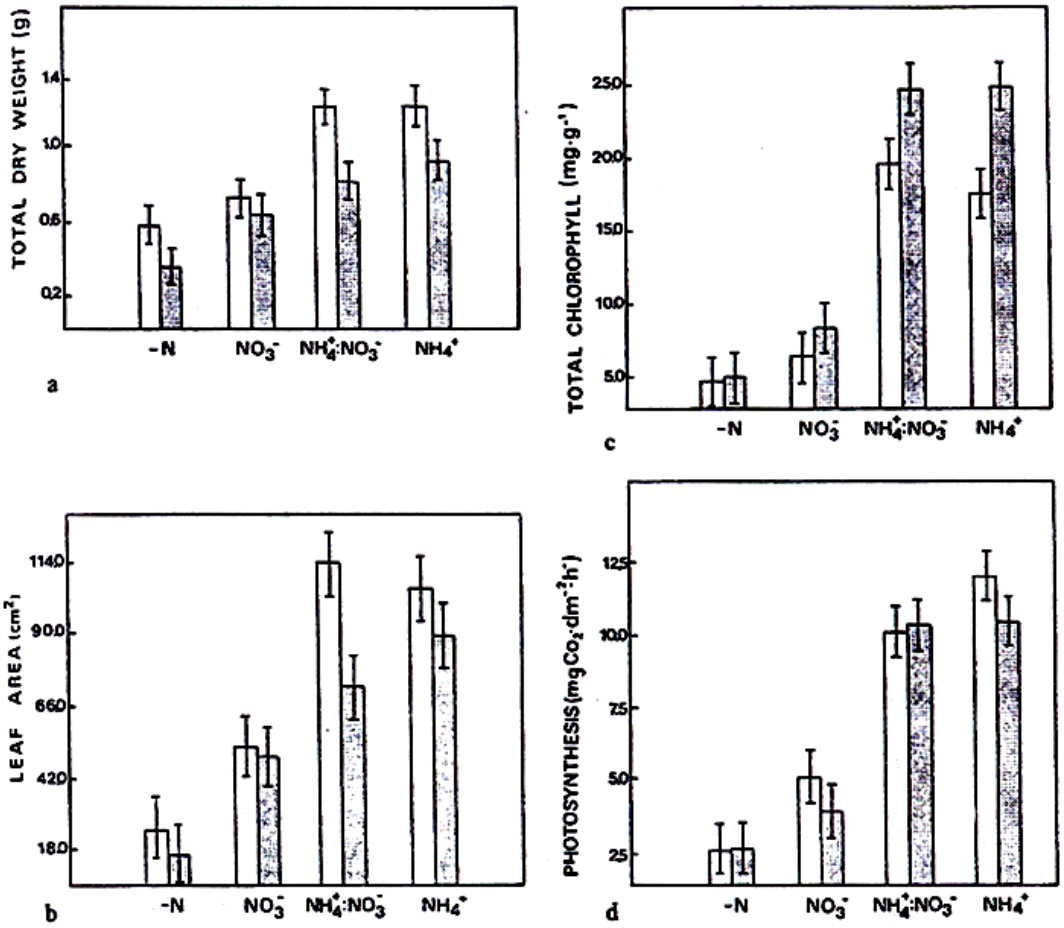

Fig. 51.1. Total dry weight (a), leaf area (b), total chlorophyll (c), photosynthetic rate (d), and nitrogen content (e) of carob plants after 3 months growth on hydroponic culture. Plants with cotyledons ▭ ; plants without cotyledons ▭ . Each value is the mean of ten plants ± LSD (5%)

Growth of plants during the first month of hydroponic culture was similar, both in the presence and absence of nitrogen, which seems to indicate that the early plant growth in carob is principally dependent on stored nitrogen. The importance of cotyledons is indicated by these experiments, whereby significant growth differences were observed between plants grown with and without cotyledons. It, therefore, appears that the cotyledons, besides maintaining their own physiological activity, are involved in growth regulation at least during the initial growth phase studied in these experiments. This growth regulation is brought about not only by their photosynthetic activity, but possibly also through the regulation of the "sink" metabolic balance between shoot and root. Plants grown in the absence of nitrogen exhibited

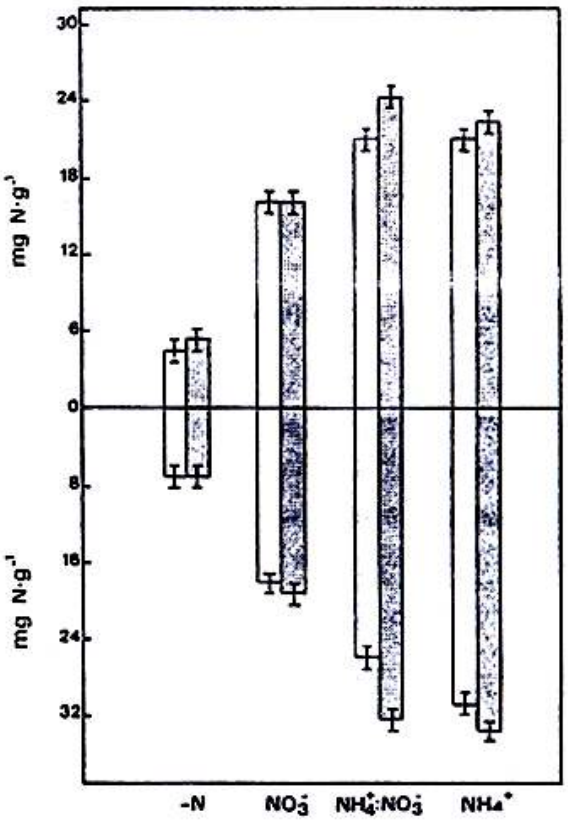

Fig. 51.1e (legend see p. 251)

nitrogen deficiency symptoms (Clarkson and Hanson 1980). Ammonium-nitrogen, either alone or in combination with nitrate-nitrogen, appeared to favor the growth of carob demonstrated by an efficient assimilatory system in terms of shoot growth, leaf area, and dry weight production.