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Tolérance à la salinité d'une poaceae à cycle court : la sétaire (*Setaria verticillata* L.)

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Résumé

La tolérance à la salinité a été examinée chez *Setaria verticillata* L., graminée estivale à cycle court, en conditions contrôlées de laboratoire. Les semis ont été effectués sur de la tourbe commerciale et les plantules obtenues repiquées sur le même substrat imbibé par capillarité avec de l'eau distillée, éventuellement additionnée de NaCl (50 à 300 mM). La détermination de la masse de matière sèche des plantes après trois semaines de culture sur les différentes concentrations en NaCl montre que la sétaire est très sensible à la salinité. Pendant les premiers stades de son développement, la concentration en NaCl qui provoque 50% d'inhibition de la croissance pondérale est de l'ordre de 75 mM. La réduction de croissance semble associée à une forte accumulation de Na^+ dans la plante et à un déficit d'approvisionnement des organes aériens en K^+. Cette sensibilité à NaCl se retrouve pendant la phase reproductive, après 3 mois de culture. Le sel affecte négativement les composantes du rendement. La capacité germinative des grains obtenus dans ces conditions diminue avec la concentration en NaCl du milieu de culture des plantes mères et s'annule pour ceux récoltés sur NaCl 300 mM. ***Pour citer cet article : H. Ben Ahmed et al., C. R. Biologies 331 (2008).***

Abstract

Salt tolerance of *Setaria verticillata* L.: a short-cycle poaceae. The responses of growth, development, and nutrition to salt stress are examined in short-cycle *Setaria verticillata.* For these, two experiments are led. The first intended to study the effects of various concentrations of NaCl on the parameters of growth and nutrition during the vegetative phase. Fifteen-day-old platelets were grown on commercial peat irrigated with pure NaCl solutions (0 to 300 mM). After three weeks of culture, the plants were collected and divided into roots and shoots. The fresh and dry matter masses of the various bodies are given. The second experiment was intended to study the effect of different concentrations of NaCl on crop plants until maturity. The culture was led under the same conditions as the preceding one, but for three months until the end of the cycle (production and maturation of the seeds). At harvest, the plants were separated in roots, shoots, and grains. During all the development cycle, *Setaria vertillata* was very sensitive to salinity. The concentration of NaCl that caused an important reduction of dry weight production was about 75 mM. Dry matter deposition was more diminished in roots than shoots. The reduction of the production of growth observed seems associated with a higher accumulation of Na^+ in shoots and with a deficit alimentation of organs in K^+. During the reproductive phase, salt affects the components of the output and induces variability on the level of the production of biomass as significant as that noted during the phase of vegetative growth. Lastly, the capacity of germination of seeds was strongly dependent on the salt concentration

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of the culture medium of the plants mothers, a total loss of viability appearing on crop plants collected in the presence of NaCl 300 mM. ***To cite this article: H. Ben Ahmed et al., C. R. Biologies 331 (2008).***

Mots-clés : Setaria verticillata ; NaCl ; Croissance ; Développement ; Nutrition minérale

Keywords: Setaria verticillata; NaCl; Growth; Development; Mineral nutrition

Abridged English version

Excessive soil salinity is an important constraint limiting the distribution of plants in natural habitats, and is an increasingly severe agricultural problem in arid and semiarid regions. About 15 million hectares are affected by salinity in the Maghreb and the Middle East. In Tunisia, the (semi)-arid Mediterranean bio-climatic regions are frequently irrigated with salt-enriched water. Consequently, about 10% of the whole territory and 20% of the cultivated lands are saline. Several solutions were advanced to attenuate the risks incurred by the agronomic production. However, such solutions are expensive and difficult to implement. As an alternative, one can minimize the unfavourable effects of salinity on the output of the cultures by the selection of species and varieties better adapted to the conditions of salinity. In spite of the multitude of work carried out on the responses to salinity in the halophytes as well as in the glycophytes, the data concerning the effect of salinity on the output in grains and its components are rare. The heaviness of the approaches suggests that it is convenient to work on plants with short cycles. The objective of this work is to evaluate the tolerance to salinity of the spontaneous Graminaceae with short cycle (three months), *Setaria verticillata*, during its entire cycle of development, based of growth, output, and mineral nutrition parameters. Fifteen-day-old plantlets were grown on commercial peat irrigated with pure NaCl solutions (0 to 300 mM) with 16-h photoperiod (100 $\mu mol\,m^{-2}\,s^{-1}$ PAR), and temperature comprised between 25 °C (day) and 19 °C (night). Growth and development were monitored during the entire developmental cycle (ca three months). Samples were harvested for biomass determinations and ion content assays after three weeks of NaCl treatments. The samples were divided into roots and shoots, bagged and dried at 80 °C for at least 48 h. Dried leafs and root tissues were extracted in HNO_3 0.1 N for 48 h. K^+ and Na^+ contents were estimated with an Eppendorf flame photometer.

During the whole development cycle, Setaria was a very sensitive species to NaCl. Dry weight of the vegetative organs of young plants is decreased at all the added levels of sodium chloride. The lowest NaCl concentration (50 mM) caused a significant reduction of dry weight production, for both roots and aerial parts. A 50% decrease of dry weight production was observed at 75 mM NaCl. At concentrations higher than 50 mM, dry matter deposition was more diminished in roots than in shoots, resulting in higher shoot/root ratios. This depressive effect of NaCl is observed in older plants (three months). However, the ear biomass is only affected for NaCl concentrations higher than 100 mM. The reduction of dry weight production, observed after three weeks at 50 mM NaCl, was associated with a high accumulation of Na^+ and Cl^- and a significant reduction of the K^+ content in shoots. Potassium and calcium contents were significantly diminished in the plants, perhaps because of a restriction of external NaCl root absorption. This effect was much more pronounced for K^+ than for Ca^{2+}. However, the plant remains always selective to K^+. In fact, the K/Na ratio determined in shoots and roots is reduced by salinity, but remains higher than the K/Na ratio calculated in the medium. During the reproductive phase, salt affects the components of the output and induces variability of the level of biomass production as significant as that noted during the phase of vegetative growth. Lastly, the germination capacity of seeds was strongly dependent on the salt concentration in the culture medium of the mother plants, a total loss of viability appearing on crop plants collected in the presence of 300 mM NaCl.

1. Introduction

La salinité des sols et des eaux d'irrigation compte parmi les principaux facteurs qui limitent la productivité végétale [1]. Le problème de la salinité prend de plus en plus d'ampleur dans la plupart des pays en voie de développement, où les terres fertiles et les eaux de bonne qualité sont devenues nettement insuffisantes pour une population sans cesse croissante [2]. En Tunisie, les sols salés occupent une superficie de 1,5 millions d'hectares, soit à peu près 25% de la surface totale des sols cultivables du pays [3]. Plusieurs solutions ont été avancées pour atténuer les risques encourus par la production agronomique [4,5]. Cependant, de telles solutions sont coûteuses et difficiles à mettre en œuvre. Comme alter-