# Acadian *Ascophyllum nodosum* Extract Improves Early Root Growth and Plant Establishment in Vegetable and Bedding Plant Seedlings and Field-Grown Lettuce and Strawberries©

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## EXPANDED ABSTRACT

Many vegetable field crops such as tomato, melon, and lettuce are grown in plug trays under greenhouse conditions prior to transplanting into the field. The development of a large, robust root system is essential for early plant establishment and allows young seedlings to withstand any number of transplant stresses.

Seaweed extracts have been shown in bioassay, greenhouse, and field studies to improve root and shoot development of various agricultural plants as well as to alleviate some symptoms typically associated with biotic and abiotic stresses (Khan et al, 2009). Greenhouse experiments at Acadian Agritech's® research center in Cornwallis, Nova Scotia, were designed to test the effects of Acadian seaweed extracts (a derivative from the marine algae *Ascophyllum nodosum*) on root development in lettuce, watermelon, mung bean, pansy, and cosmos. Lettuce and strawberry were also examined in field studies comparing growth effects of Acadian *A. nodosum* extract to standard grower programs for these crops.

Following several weeks of growth in the greenhouse, a WinRhizo root image analysis system was used to measure root growth in Acadian-extract-treated and control lettuce and watermelon. Greenhouse trials showed enhanced root growth with extract treatment. Further greenhouse studies were performed on pansy and cosmos and showed positive effects of the extract on these representative ornamental crops. Field studies were conducted to test the effects of Acadian *A. nodosum* extract on root growth in lettuce and strawberry crops, where increases in root growth were also seen.

In a short bioassay, roots were removed from uniform mung bean seedlings and the remaining stems (with leaves) placed in solutions of either *A. nodusum* extract [1 g soluble seaweed extract powder (SSEP) per litre water] or a synthetic auxin [indole-3-butyric acid (IBA)] at $1 \times 10^{-4}$ M and grown for 5 days.

In the greenhouse studies, replicated trials showed significant improvements in root length, surface area, and volume when Acadian was applied as a drench [1 g SSEP per litre water] to seedlings of vegetables and bedding plants compared to the fertilizer controls 10-52-10 at 1 $g \cdot L^{-1}$. An LSD statistical analysis (5%) was used to identify significant differences in root length, volume and surface area between the fertilizer control and the Acadian plus fertilizer treatment.

For watermelon, data show a 37.5% increase in total (cumulative) root length, a 25.5% increase in root surface area, as well as a 13.6% increase in total root volume (Fig. 1).

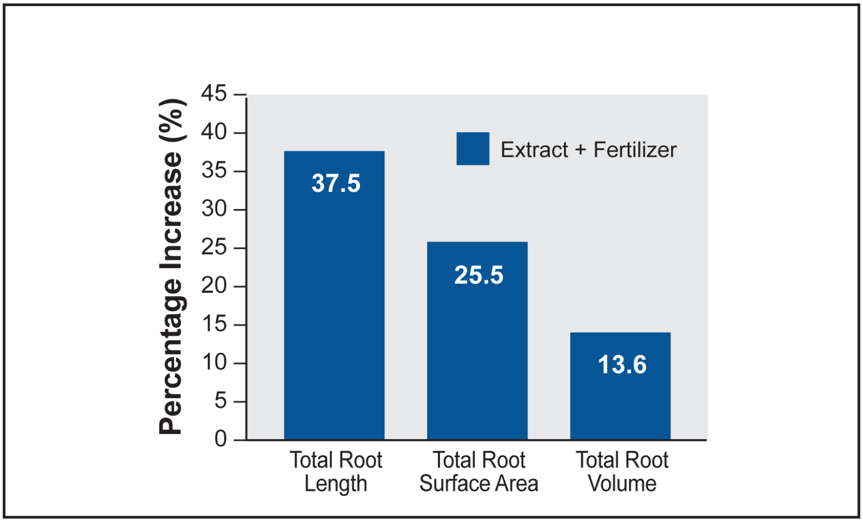


**Figure 1.** Effect of Acadian *Ascophyllum nodosum* seaweed extract on watermelon root development (average cumulative root length, surface area, and volume).

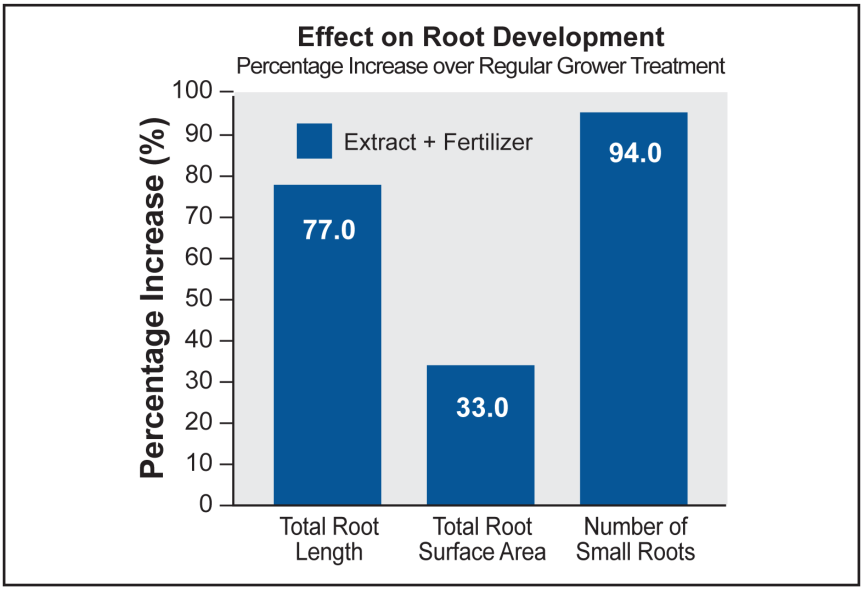


**Figure 2.** Effect of Acadian *Ascophyllum nodosum* seaweed extract on lettuce root development (average cumulative root length, surface area, and number of small roots).

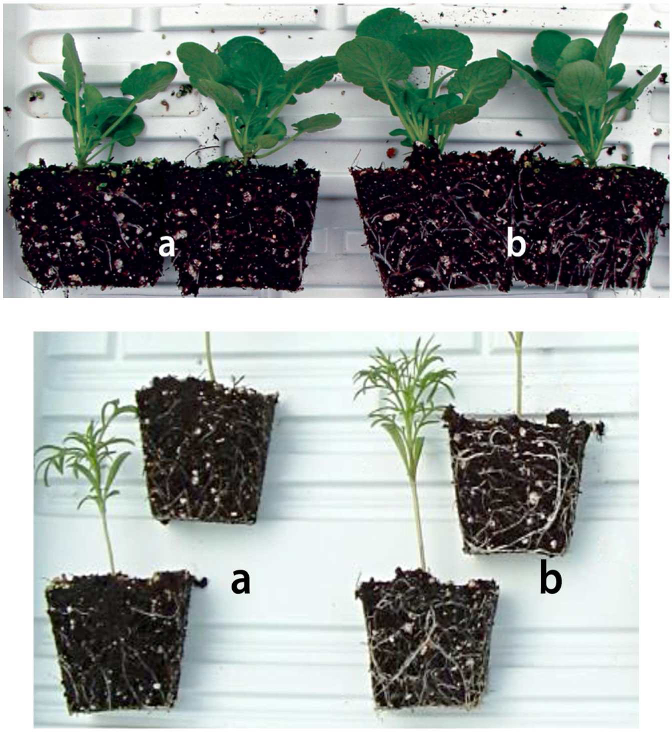


**Figure 3.** Photos of cosmos (bottom) and pansy (top), showing enhanced root and foliar growth in *Ascophyllum nodosum* extract-treated plants (right) versus plants receiving fertilizer alone (left).

For lettuce, similar increases were observed in total root length, surface area and number of smaller roots (Fig. 2). This can also be compared with visual evidence from WhiRhizo root image scans in Figure 5 showing a dramatic increase in root development in treated versus untreated plants sampled from the field. Moreover, the enhanced rooting effect from extract applications has been noted in several other plants species (tomato, pepper, ornamental species; Norrie and Hiltz, 1999; Khan et al., 2008).

Experiments on ornamental species such as cosmos and pansy indicate a similar effect on early root establishment (Fig. 3).

A bioassay using de-rooted mung bean seedlings was used to compare root initiation and elongation between Acadian *A. nodosum* extract and synthetic auxin (IBA) treatments following a 5-day period. Differences in root elongation can clearly be seen between the two treatments (Fig. 4). Although both control and *Ascophyllum* treatments resulted in root initiation and primordia development, the Acadian


**Figure 4.** Mung bean roots showing typical Acadian *Ascophyllum nodosum* extract-treated growth response (b) and a typical response to synthetic auxin IBA (a).

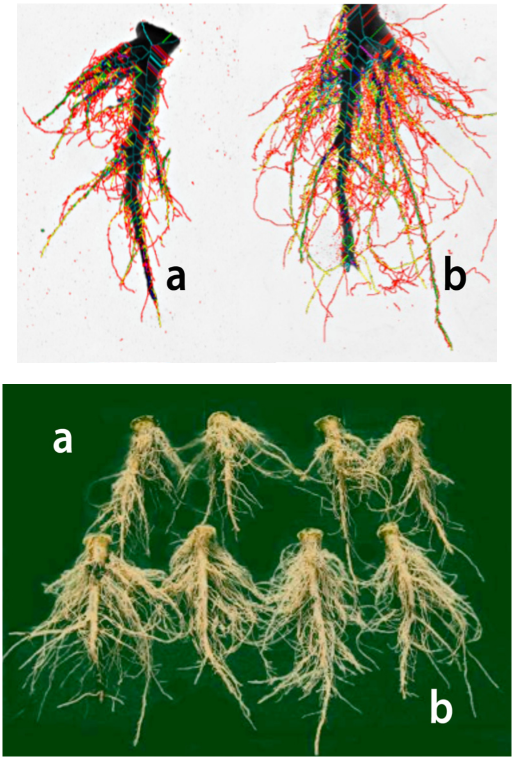


**Figure 5.** Lettuce roots as scanned by the WinRhizo root image analysis system showing Control (a) and *Ascophyllum nodosum* extract-treated (b) plants (top image) as well as a photo (lower image) of Control [top row (a)] and treated [bottom row (b)] roots 54 days after planting. Plants were given early root drench applications of Acadian *A. nodosum* extract.


**Figure 6.** Samples of eight plants taken from Acadian's *Ascophyllum* extract-treated plots (bottom) and control plots (top) 9 weeks after planting. Top growth and root biomass were visually more developed in treated versus control treatments. Harvest information indicated significantly earlier and higher yields in treated plots resulting in a substantial increase in grower revenue.

treatment consistently showed significant root elongation along the basal stem section relative to the IBA solution.

In a commercial strawberry field in California, improvements in root length and above-ground vegetative development were clearly visible in plants sampled from Acadian *A. nodosum* seaweed extract-treated plots versus the grower's standard fertilizer applications (Fig. 6).

## CONCLUSION

Combined results from bioassay, greenhouse, and commercial experiments comparing Acadian *A. nodosum* seaweed extracts demonstrate a consistent enhancement of root development and plant establishment following extract treatment. Acadian is continuing to examine the overall effects of *A. nodosum* seaweed extracts in short- and long-term growth of various plant species. In addition, the molecular basis for enhanced growth response to *A. nodosum* seaweed extracts is being studied at the Nova Scotia Agricultural College (Prasanth et al., 2009; Rayirath et al., 2009). These studies include an examination of plant resistances to biotic (bacterial) and abiotic (chilling, salinity, and drought) stresses, and the ability of Acadian extracts to help mitigate potential reductions in plant development, yield, and or quality. Using *Arabadopsis* as a model crop, successfully developed protocols and technologies are transferred to Acadian research facilities where they are tested on other crop species such as those discussed in this paper. Time-lapse photography has also provided an additional impressive tool with which to monitor Acadian *A. nodosum* effects on rooting and their response to different stresses.

## LITERATURE CITED

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