

Effect of seaweed concentrate on the growth of wheat

Various seaweed preparations impart beneficial growth effects on treated terrestrial plants.¹ In cereals, such preparations improve yield, nutrient uptake and stem thickness.²⁻⁴ While the components of the seaweed responsible for the growth stimulation are not known, it is thought that cytokinin activity is of importance.⁵⁻⁷ With respect to root growth, recent experiments have indicated that low concentrations of seaweed concentrate could mimic the effect of low levels of cytokinin. The stimulatory effect of the seaweed was lost if the material was ashed.⁸ This clearly indicates that the regulatory effect is associated with the organic fraction rather than with the inorganic components. This investigation was conducted to document more fully the effects of seaweed concentrate on wheat growth.

Triticum aestivum L. cv. Inia plants were grown in a growth chamber (16 h light at 20°C and 8 h dark at 15°C) in pots (300 cm³) filled with a sandy-loam soil mix. The plants were not fertilized and were watered three times weekly with tap water (100 cm³). Plants were thinned to three per pot one week from sowing.

Seaweed concentrate, marketed as Kelpak 66, and prepared from *Ecklonia maxima* (Osbeck) Papenfuss by a cold, cell-burst process, was applied as a soil flush in 100 cm³ distilled water. Earlier experiments^{9,10} have shown that low levels of seaweed concentrate stimulated root development and plant yield irrespective of whether applied as a root drench or foliar spray. For ease of application the former procedure was used in this experiment. In the first experiment, seaweed application commenced one week after germination and consisted of eight equal applications applied at weekly intervals. The total volume of seaweed which the different treatments received was 0, 0.1, 0.05, 1.0 and 2.0 cm³ per pot. In a separate experiment the effect of a single application (0.5 cm³) of seaweed concentrate applied at different stages of plant development was investigated. These applications were made one, three or five weeks after planting, corresponding with early (stages 1-2), late (stages 6-8) and post (stage 17-19) inflorescence differentiation, respectively. In addition, caryopses were soaked for one hour in a 1:100 dilution of seaweed concentrate prior to planting. All experiments were terminated when the plants had reached physiological maturity. Treatments consisting of six replicates were laid out in randomized blocks and an analysis of variance conducted on the data. Mean separation was conducted by *t*-test ($P = 0.05$) unless the *F*-test indicated no significant differences.

Grain material was digested by a semi-micro Kjeldahl technique and total nitrogen¹¹ determinations conducted on the digest.

Application of seaweed concentrate resulted in the development of more robust plants with darker green leaves which senesced more slowly than those of the controls.

Production of root and shoot dry mass increased with an increased level of seaweed application (Table 1). At levels of 0.05 and 1.0 and 2.0 cm³ seaweed concentrate kernel mass was significantly higher than that of the control. The optimum yield was, however, obtained at 1.0 cm³ of seaweed concentrate. This indicates that the seaweed does not have a direct nutrient effect but acts as a growth stimulant as has been shown earlier.³⁻⁸ With respect to the increase in kernel yield, it is noticeable that the number of spikelets which formed on the inflorescences increased significantly with an increase in seaweed application, thus increasing the yield potential of the treated plants. This potential was realized to a greater extent in those treatments where 0.05 and 1.0 cm³ of seaweed concentrate were applied. This is indicated by an increased percentage of fertile spikelets and number of caryopses. The increased yield was in part due to the kernels being heavier.

As reported earlier,⁴ seaweed concentrate resulted in the development of thicker culms (Table 1). Culm length was affected to a lesser degree. From the culm length: culm diameter ratio it is evident that the effect of the seaweed concentrate was greater on culm diameter than on culm length.

With respect to the quality of the kernels produced, the higher level of seaweed concentrate significantly increased the percentage of total nitrogen in the caryopses. Although fewer kernels were formed at an application level of 2.0 cm³ of seaweed, the nitrogen content of these kernels increased to 3.16%. This indicates that nitrogen transport to the kernels was stimulated.

The results obtained with a seed soak (1:100 dilution) or with single applications of seaweed concentrate at different stages of development were not as pronounced as those obtained for the earlier experiment where the seaweed concentrate dosage was spread over a period of time. A single application was only beneficial if applied during the early stages of plant growth. Once the inflorescence had developed, yield was not improved. The growth parameters which were significantly improved by a single application during the early stages of wheat growth were root dry mass and the number of spikelets formed.

From the present results it is clear that the beneficial effect of seaweed concentrate on wheat yield is due partly to stimulation of certain growth parameters during the early stages of plant development, and partly to a delaying of senescence and better redistribution of assimilates during the reproductive stages of growth. For the overall effect to be optimised, it is apparently necessary to apply the seaweed concentrate during early vegetative growth and then to consolidate the effect with one or more applications during the early reproductive phases. In addition the seaweed must be applied at the correct concentration. A low level (0.01 cm³) did not stimulate growth, whereas a high level increased vegetative growth but did not result in optimal kernel yield. Similar effects have been reported for other crops.^{9,10}

Table 1. The effects of different levels of seaweed concentrate applied as a soil flush on the growth of wheat. Mean separation is by *t*-test. Means followed by the same character are not significantly different ($P = 0.05$).

Parameter measured	Seaweed concentrate applied (cm ³)					s.e.m.
	0	0.01	0.05	1.0	2.0	
Root dry mass (g pot ⁻¹)	0.23 ^a	0.26 ^a	0.34 ^a	0.37 ^a	0.51 ^a	0.03
Shoot dry mass (g pot ⁻¹)	0.35 ^a	0.37 ^a	0.72 ^b	0.75 ^b	0.93 ^b	0.03
Total vegetative material (g pot ⁻¹)	0.58 ^a	0.63 ^a	1.06 ^b	1.12 ^b	1.44 ^b	0.06
Kernel mass (g pot ⁻¹)	0.19 ^a	0.19 ^a	0.64 ^b	1.74 ^c	0.34 ^a	0.04
Total plant dry mass (g pot ⁻¹)	0.77 ^a	0.82 ^a	1.70 ^b	2.86 ^c	1.78 ^b	0.06
Number of spikelets per pot	21.18	22.38	26.79	31.41	34.47	0.72
Spikelets fertile (%)	27.6 ^a	27.6 ^a	69.0 ^b	57.6 ^b	26.3 ^a	4.27
Number of kernels per pot	5.8 ^a	5.9 ^a	18.1 ^b	18.6 ^b	9.0 ^a	1.25
Average grain mass (mg)	32.7 ^a	32.2 ^a	35.3 ^b	93.5 ^c	37.8 ^b	3.01
Culm diameter (mm)	0.87 ^a	0.89 ^a	1.12 ^b	1.26 ^b	1.41 ^b	0.03
Culm length (cm)	29.76 ^a	30.63 ^a	37.64 ^b	31.60 ^b	29.11 ^a	0.72
Culm length: culm diameter ratio	33.90 ^a	34.26 ^a	33.89 ^a	25.31 ^b	20.75 ^c	0.95
Total kernel nitrogen (%)	1.92 ^a	2.06 ^a	1.75 ^a	2.35 ^b	3.16 ^b	0.09