Orkney Seaweed Company Ltd

Report on Independent Trials of the Base Product employed in it's range of Seaweed Growth Promoter Products :

Teagasc and Farm Future Trials during EU ECLAIR Programme

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PART I Overview

The formulation of the base product being manufactured by the Orkney Seaweed Company Ltd was established after a series of major trials undertaken over the period 1990-1994, with major funding from the EU ECLAIR initiative. The target of the project was to develop, from first principles, a plant growth promoter product for application in organic agriculture.

The programme was under the direction of Professor Cliff Johnston, then Director of the Institute of Offshore Engineering at Heriot-Watt University in Edinburgh (a biologist who has worked on seaweeds since the 1960s). The process development used engineering facilities at the Orkney Water Technology Centre (OWTC). Field trials, which focused on organic agriculture, were undertaken by two organisations:

- Teagasc - Irish Agriculture and Food Development Authority; under the direction of Dr F.S.MacNaeidhe at the Johnstown Castle Research Centre, Wexford.

- Farm Future - under the direction of BDAA/Demeter Fieldsman - Jim Anderson.

During the period from 1995 to 1998, efforts concentrated on:

- developing an environmentally acceptable seaweed harvesting strategy
- scaling up the production process, and
- preliminary trial marketing of the base product, in its base form and within other proprietary formulations in the organic agriculture, commercial horticulture and turf management sectors.

The company - Orkney Seaweed Company Ltd, was actually registered in 1988, but was only 'mobilised in 2000. Over the last two years, company financing was established, including the establishment this year of a production facility on the Orkney island of Westray.

The ECLAIR programme had a wider remit than the development of the single product which forms the basis to the present 'base product'. The data presented here, are abstracted from the wider programme findings (in part still confidential), but represent an accurate review of relevant trials undertaken by both Teagasc and Farm Future.

PART II Teagasc Agricultural Research Station Trials, Ireland

1. TEAGASC Sites

Seventeen experimental sites were selected during the winter and spring of 1991 and 1992, and fourteen of these (1-14) were retained for organic trials in 1993. The sites were selected on different soil types which varied in texture from sandy loam to clay loam. The soil type. classification and origin at each of the experimental sites is shown in Table 1. All of the soils are located in the east, south-east and south of the country in the region, where most of the intensive agriculture is practiced. In general, the acid brown earth soils have the most wide use range and are regarded as the best soils. The grey brown podzolic and brown podzolic soils are also excellent soils with a wide use conservation. Soils of shale origin have a low pH when unlimed but are deep and fertile when well managed. These soils are low in phosphorus (P) and zinc (Zn). Soils of sandstone origin are also good arable soils, are well drained but have a low soil pH when unlimed and are low in copper (Cu). Soils of limestone origin have a moderate to high pH and adequate mineral supplies but may fix applied potassium and are occasionally deficient in this element. Soils derived from granite have a low soil pH and a lower supply of all minerals compared with the above soil types.

The soil fertility at the different sites varied from high to low. The soils in sites 1-14 were farmed organically and in most cases the mineral concentrations in these soils were lower than in farms which were farmed conventionally. Sites 15-17, used in the 1991-92 trials were conventionally farmed.

Table 1. Soil type and origin at each of the experimental sites.

Site	Soil type	Classification	Parent Material
1	Clay loam	Brown podzolic	Shale/Mica schist
2	Loam	Acid brown earth	Ordovician shale
3	Loam	Grey brown podzolic	Shale/Limestone
4	Sandy loam	Acid brown earth	Granite
5	Loam	Acid brown earth	Granite
6	Clay loam	Grey brown podzolic	Limestone/shale
7	Loam	Brown podzolic	Sandstone
8	Loam	Brown podzolic	Shale/Mica schist
9	Loam	Acid brown earth	Ordovician shale
10	Clay loam	Grey brown podzolic	Limestone/shale
11	Loam	Acid brown earth	Granite
12	Loam	Acid brown earth	Granite
13	Clay loam	Grey brown podzolic	Shale/Limestone
14	Loam	Brown podzolic	Sandstone
15	Loam	Grey brown podzolic	Sandstone/shale/all.
16	Gravel Loam	Grey brown podzolic	Limestone till
17	Fen Peat	Basin Peat	Fen species

Several organic soils of high fertility were included in the experiments in 1993. The nutrient status of the soils of the experimental sites is shown in Table 2.

The soil at sites 1, 2, 7, 8, 9, and 14 had a low fertility status due to low inputs of fertilizers over a period of a decade. All of these sites were organic sites. Soil fertility at sites 3, 4, 5, 6, 10, 11, 12 and 13 was high. At sites 3, 6, 10 and 13 conversion to organic status had taken place only in the previous 3 years and some residual minerals from a synthetic source were still present in the soil. Sites 6, 7 and 14 were organic sites where intensive horticultural cropping was being carried out. Dressings of farmyard manure were being applied at these sites and the soil fertility was high.

Table 2: The nutrient status of the experimental sites (1993 status).

Site	pH	P	K	Mg	Mn	Cu	Zn	Fertility status	Farming system
1	5.9	1	96	191	240	2.4	2.7	Low	Organic
2	6.7	1	96	394	231	3.6	5.9	Low	Organic
3	5.9	6	213	94	70	2.3	2.1	High	Organic
4	6.7	17	380	283	119	7.2	6.0	High	Organic
5	6.8	19	371	307	151	6.9	4.9	High	Organic
6	6.3	5	210	101	65	2.0	1.9	High	Organic
7	6.7	3	81	68	507	5.2	3.3	Low	Organic
8	6.4	1	90	191	231	2.1	3.3	Low	Organic
9	7.0	4	82	90	66	2.1	3.1	Low	Organic
10	6.0	5	205	91	60	2.1	1.7	High	Organic
11	6.6	11	361	251	230	3.6	5.4	High	Organic
12	6.6	10	354	244	235	3.7	4.8	High	Organic
13	5.9	6	224	97	74	2.3	2.0	High	Organic
14	6.6	4	94	80	454	5.1	3.4	Low	Organic

2. Teagasc Experimental Design

Background

The investigation ran over three years. In 1990-1991, the preliminary or base extract was evaluated in a range of different application timings and frequencies; then in 1992 three different extracts (reflecting variations in processing) were evaluated, again under differing application levels and timings. In 1993 the focus was on one extract (extract 3 from 1992 investigations). This extract was the formulation taken forward for commercial development by the Orkney Seaweed Company Ltd.

Over all years a randomized block design (using the sites listed in Table 1) was employed with four replications for each application scenario.

The 1993 Trials

One seaweed extract was evaluated during the 1993 season in cereals, cabbage, red beet and pasture. The extract type used in this experiment was Extract type 3 from the 1992 investigations.

This extract was evaluated in two investigations i.e.

1) Effect of time and rate of application of seaweed extract on crops and pasture.

2) Effect of time and number of applications of seaweed extract on crops and pasture.

Three additional extracts were evaluated in potatoes in two investigations.

These were

3) Effect of time of application of extract type on tuber production.

4) Effect of rate of application of extract type on tuber production.

The extracts evaluated were Extract 3 from the 1992 investigations and two additional extracts, Extract 4 and Extract 5.

1) Time and rate of application of seaweed extracts

The first investigation compared the effect of rate of application of the extract when applied at different stages of crop growth. A randomized block design with four replications was used in this investigation. This experiment was carried out at sites 1 to 6. The stages of crop growth at which the treatments were applied are shown in Table 3. Three times of application were used.

Table 3. Time of application of seaweed extracts in field crops and grassland

Application	Cereals	Potatoes	Red Beet	Cabbage	Grass
1	1st Leaf	100% Emergence	1st True Leaf	2-3 weeks after planting	1st May Flush
2	4-5 Leaves	2 Weeks Later	4-5 True Leaves	2-3 Weeks Later	2-3 Weeks Later
3	Tillering	2 Weeks Later	6-8 True Leaves	2-3 Weeks Later	2-3 Weeks Later

The times of application were selected in the case of each crop on the basis of responses obtained in the preliminary investigations. A total of 10 treatments were used in each crop. These treatments are shown in Table 4. Application was made in 450 l of water. An untreated control was installed in each experiment and each treatment was compared with this control during evaluation.

Table 4: Time x Rate of application experiment in crops and grassland.

Crops: Spring oats, spring wheat, spring barley, red beet, cabbage, grass (1993)

1) T1R1	2	5	9	3
2) T2 R1,	9	10	5	4
3) T3R1	8	2	1	8
4) T1 R2	1	4	7	6
5) T2 R2	10	9	3	9
6) T3R2	5	6	4	5
7) T1 R3	4	1	8	10
8) T2R3	7	8	2	7
9) T3R3	6	3	6	1
10) Control	3	7	10	2

Time of Application : As shown in Table 3.
Rate of Application :
R1 = 4.5 l/ha
R2 = 9.0 l/ha

R3 = 18.0 l/ha

2) Time and number of applications of extract.

The second investigation compared three times and numbers of application of seaweed extract. The purpose of this experiment was to assess the most suitable number of applications of the seaweed extract which was being evaluated and the time of application. A randomized block design was used in this experiment. The sites used in this investigation were sites 8-13. The times of application used in this experiment corresponded with those in Table 3. A total of 8 treatments were used in this investigation. The treatments are shown in Table 5.

Table 5: Time x number of extract applications in crops, using Extract 3.

Crops: Cereals, Red Beet. Cabbage, Grass

Treatment	Rate (litres/ha)	Block			
1) Applic. 1	9.0	2	3	1	4
2) Applic. 2	9.0	5	6	7	3
3) Applic. 3	9.0	3	4	5	6
4) Applic. 1 + 1	9.0	7	8	2	1
5) Applic. 1 + 3	9.0	1	5	8	7
6) Applic. 2 + 3	9.0	8	7	6	5
7) Applic. 1 + 2 + 3	9.0	6	1	3	2
8) Control	9.0	4	2	4	8

Time of application: As shown in Table 3 .

Investigations in potatoes:

The experimental layouts used in the investigations in potatoes is shown in Tables 6 and 7. Time rate and method of application of the three extracts were similar to those used in the other crops.

Table 6: Extract type x time of application in potatoes (1993 example).

1)	E3T1	2	5	9	3
2)	E4T1	9	10	5	4
3)	E5T1	8	2	1	8
4)	E3T2	1	4	7	6
5)	E4T2	10	9	3	9
6)	E5T2	5	6	4	5
7)	E3T3	4	1	8	10
8)	E4T3	7	8	2	7
9)	E5T3	6	3	6	1
10)	Control	3	7	10	2

E3 - Standard Extract T1 - 100% Emergence

E4, E5 - Special T2 - 2 Weeks Later

Potato Sprays

T3 - 2 Weeks Later

3. Teagasc Trials

Cereals:

1991 Trials

The effect of time and number of applications of the seaweed extract on the yield of spring wheat and spring barley is shown in Table 7. The spring wheat was sown in late March and the three sprays were applied in late May, third week in June and early July at 9.0 l in 450 litres water per hectare. The spring barley was sown in early March and the sprays were applied in the third week in May, second week in June and last week in June. The month of May and the period up to mid-June was dry in 1991 and the sprays which were applied during this period were applied under drought or semi-drought conditions. Rainfall in the second half of June was average and rainfall for July was above average.

Application of the seaweed extract increased the yield of spring wheat and spring barley irrespective of the time of application except in the case of one treatment. Seaweed extract applied during elongation in spring wheat did not give a significant increase in grain yield. In this crop heavy rainfall occurred following the application at the elongation stage and much of spray was washed from the leaves. The lower yield in these plots was probably due to the removal of the spray from the leaves before the active ingredient entered the leaf tissue to benefit the crop.

Table 7: The effect of time and number of applications of seaweed extract on the yield of spring wheat and spring barley (1991).

Control - no seaweed	3.85	3.45
Application 1	4.85	4.28
Application 2	5.20	3.25
Application 3	4.70	4.05
Application 1 +2	4.23	3.78
Application 1 +3	4.25	4.08
Application 2+3	4.38	3.78
Application 1 +2+3	4.48	4.18
S. E. (df=21)	0.239	0.197
Extracts Average	4.58	3.91

Application 1 Post-tillering SE = standard error
Application 2 Elongation df = error degrees of freedom
Application 3 Pre-heading

1992 Trials

The effects of rate of application of the three seaweed extracts on spring oats and winter wheat is given in Table 8. Application of all three extracts at the different rates increased the grain yield of spring oats and winter wheat at sites 9 and 10 respectively.

In spring oats at site 9 the 4.5 1 rate of application was equal to the 9.0 l and 18.0 l rates. Extract 2 was slightly more effective than Extracts 1 or 3. In winter wheat at site 10 the 4.5 l rate of application was also as effective as the 9.0 l and 18.0 l rates. Extract 2 was more effective than extracts 1 and 3 at the 4.5 l and 18.0 l rates of application.

Table 8. Extract type and application rate on cereals (1992)

Treatment	Grain Yield (tonnes / hectare)		
	Site 9	Site 10	Site 11
	Spring Oats	Winter Wheat	Spring Oats
No seaweed	2.63	3.06	4.59
E1R1	3.58	3.43	4.94
E2R1	3.30	3.68	5.19
E3R1	2.82	3.42	5.31
E1R2	2.88	3.28	5.16
E2R2	3.26	3.14	5.58
E3R2	2.99	3.40	5.42
E1R3	2.64	3.58	5.37
E2R3	2.90	3.73	5.48
E3R3	3.05	3.34	5.37
S. E. (df=27)	0.12	0.11	0.22
Extracts average	3.05	3.44	5.31

1993 Trials

The seaweed extract was applied at different times and rates in spring oats, spring wheat and spring barley. The effect of time and rate of application is shown in Table 9 . At site 1 application in spring oats gave an increase in the grain yield irrespective of the time or rate of application. The crop at this site was highly variable and the differences between treatments were not significant. The largest grain yield was obtained with the 4.5 l rate of application. Application at the first leaf stage, at 4-5 leaves and at tillering were equally effective. Application at 9.0 l/ha at tillering and at 18.0 l/ha at the first leaf stage also gave a good grain yield.

Table 9: The effect of time and rate of application of seaweed extract on grain yield in cereals (1993).

Treatment	Grain Yield (tonnes/ hectare)		
	Site 1	Site 2	Site 3
	Spring Oats	Spring Wheat	Spring Barley
No seaweed	2.10	5.61	3.54
T1R1	2.97	5.22	3.58
T2R1	2.99	6.09	3.40
T3R1	2.98	6.13	3.33
T1R2	2.44	6.24	3.44
T2 R2	2.19	5.99	3.25
T3R2	2.70	6.56	2.59
T1R3	2.77	5.84	2.49
T2R3	2.41	5.93	3.00
T3R3	2.40	6.24	3.31
S. E. (df=27)	0.41	0.37	0.59
Extract average	2.65	6.02	3.15

Red Beet

1992 Trials

The red beet crop were sown in early June and developed quite rapidly following emergence. The first and second sprays were applied in late June and early July. Application of the third spray was delayed due to poor weather conditions and the crop developed beyond the stage of application so that no third spray was applied in this crop. The effect of time of application of the three extracts on the yield of red beet roots is shown in Table 10. All three extracts gave an increase in the root yield at all times of application compared with the control treatment.

However, there was a high degree of variability which was not related to treatment effects among the plots in the experiment and the yield difference between treated and unsprayed plots was not entirely due to treatment effects but was partly due to natural variation. Nonetheless the yield difference between the control and the treatments was significant at the 5% level.

Table 10: The effect of time of application of seaweed extracts on the root yield of red beet (1992)

Treatment	Rate litres/ ha	Root Yield (t/ha)
No Spray	-	23.5
E1T1	9.0	37.4
E2T1	9.0	34.6
E3T1	9.0	30.4
E1T2	9.0	33.6
E2T2	9.0	28.5
E3T2	9.0	27.3
S.E. (df = 18)		2.74
Extract average		31.97

1993 Trials

Red beet was sown at Site 4. All three rates were applied at the first true leaf stage, at the 4-5 true leaf stage and at the 6-9 true leaf stage of the crop. Heavy rainfall occurred after application at the 4-5 true leaf stage and application at this time was less effective than the earlier and later applications. The largest root yield was obtained with application of 9.0 l/ha of seaweed extract at the first true leaf stage of the crop. Application of 4.5 l/ha at the 6-9 leaf stage also gave a good root yield. Application of 4.5 l/ha and 18.0 l/ha at the first true leaf stage did not give a root yield which was equivalent to these two treatments. The effect of treatment on root yield is shown in Table 11.

Table 11: The effect of time and rate of application of seaweed extract on root yield of red beet (1993).

Treatment	Yield (t/ha)
	Site 4
No seaweed	22.1
T1 R1	24.4
T2R1	24.8
T3R1	31.1
T1R2	33.8
T2R2	19.0
T3R2	26.2
T1R3	25.0
T2R3	24.0
T3R3	25.0
S. E. (df=27)	2.09
Extracts average	25.9

Carrots (1992):

The carrot crop was sown in June and was treated with the seaweed extracts in July and August. The effect of the different treatments on carrot root yield is given in Table 12. All except one treatment gave a larger yield compared with the control plot. Extract 2 gave the largest yield with the second application applied in July. Extracts 1 and 3 gave the largest yield with the third application. An analysis of carrot leaves and roots was carried out to evaluate the effect of time of seaweed extract application on the elemental contents of carrot leaves and roots. All the seaweed extract sprays decreased the concentrations of nitrogen in the carrot leaves.

Table 12: The effect of time of application of seaweed extracts on carrot root yield (1992)

Treatment	Rate litres /ha	Root Yield (t/ha)
No seaweed	-	14.8
E1T1	9.0	17.5
E2T1	9.0	14.8
E3T1	9.0	19.0
E1T2	9.0	15.4
E2T2	9.0	19.5
E3T2	9.0	19.2
E1T3	9.0	20.3
E2T3	9.0	16.7
E3T3	9.0	22.3
S.E. (df = 18)		0.63
Extracts average		18.3

In a second trial in 1992, carrots were grown on two soil types - peat and mineral soil. A conventional system of cropping was used with both crops. The effect of rate of application of the seaweed extracts on carrot root yields is shown in Table 13. On peat soil the crop was variable and significant differences in root yield could not be detected. The variability was also high in the crop on mineral soil but differences between treatments were recorded. Application of Extract 1 at 4.5 1/ha gave the largest crop yield on this soil type. Extract 3 also gave good crop yields at the three rates of application used. Extract 2 gave a good yield only at the high rate of application (18.01/ha).

Table 13 : The effect of rate of application of seaweed extracts on carrot root yield in peat and mineral soils (1992)

Treatment	Rate (litres/ha)	Carrot Yield (t/ha)	
		Site 16	Site 17
		Peat	Mineral soil
No Seaweed	-	74.0	49.9
E1T1	4.5	68.6	68.6
E2T1	4.5	71.6	45.4
E3T1	4.5	78.7	58.4
E1T2	9.0	69.5	49.6
E2T2	9.0	82.3	40.0
E3T2	9.0	76.3	60.0
E1T3	18.0	76.3	45.6
E2T3	18.0	66.1	53.7
E3T3	18.0	71.7	58.1
S.E. (df = 27)		4.1	2.1
Extracts average		73.5	53.3

Red Cabbage

1992 Trials

The red cabbage was transplanted in May and treated in early June, following successful establishment. The yield of mature heads is given in Table 14. Application of all three extracts at the different rates reduced the nitrogen concentrations in the heads.

Table 14 : The effect of rate of application of seaweed extracts on the yield of red cabbage (1992)

Treatment	Rate/ litres/ha	Yield (t/ha)
		Site 14
No Seaweed	-	31.8
E1R1	4.5	31.5
E2R1	4.5	38.5
E3R1	4.5	41.2
E1R2	9.0	34.2
E2R2	9.0	35.4
E3R2	9.0	35.7
E1R3	18.0	34.3
E2R3	18.0	35.7
E3R3	18.0	31.5
S.E. (df = 27)		1.70
Extracts average		35.3

1993 Trials

This crop (Table 15) was treated with combined and single applications at establishment, 19 days after transplanting, at 35 days after transplanting and 55 days after transplanting. The crop was planted at Site 12. Application at establishment and repeated after 35 days gave the largest yield of mature single application applied after 55 days also gave a large yield of mature heads. A single application made at crop establishment gave no yield increase. This treatment and application at establishment and 55 days later gave the largest decrease in foliar nitrogen. The remaining treatments gave only a slight reduction in foliar nitrogen or none at all. No reduction in foliar phosphorus occurred with any of the treatments. All treatments have an increase in the foliar concentration of potassium. The largest increase was recorded with a single application of extract 35 days after transplanting and with a combined application at establishment and 35 days after transplanting. Application at establishment and repeat applications 35 days and 55 days later also gave a good increase in potassium concentration in the foliage.

Table 15: The effect of time and number of application of seaweed extract on yield of red cabbage (1993)

Treatment	Yield (t/ha) Site 12
No seaweed	50.4
Application 1	48.2
Application 2	55.4
Application 3	57.8
Applic. 1 + 2	59.1
Applic. 1 + 3	57.0
Applic. 1 + 2 + 3	51.7
Applic. 2 + 3	52.8
S. E. (df=? 1)	4.00

Extract average 54.6

Grassland

1992 Trials

The effect of time of application of the three extracts on grassland is given in Table 16. The first application of the three extracts was made in mid-May after the first strong flush of growth which occurred in April. The second and third sprays were applied at 18 days and 10 days respectively afterwards.

A significant yield increase of herbage was obtained with application of Extract 1 in early June. Early June application gave a better overall yield than mid-May or mid-June application. Extract 2 gave the largest yield when applied in mid-May but gave the smallest yield with application in mid-June.

Table 16 : The effect of time of application of seaweed extracts on growth of grass in pasture at site 4 (1992).

Treatment	Rate litres/ha	Grass Yield (t/ha)
No seaweed		12.6
E1T1	9.0	14.3
E2T1	9.0	15.1
E3T1	9.0	14.6
E1T2	9.0	17.4
E2T2	9.0	15.9
E3T2	9.0	15.5
E1T3	9.0	15.2
E2T3	9.0	12.3
E3T3	9.0	15.6
S.E. (df = 27)		1.04

Extracts average 15.1

1993 Trials

The three rates of seaweed extract were applied at the first flush of growth in the 1st week of May, in the 3rd week of May and the 2nd week of June. The sward was harvested in the 3rd week of June. The largest herbage yield was obtained with the application of 18.0 l/ha of seaweed extract at the first growth flush in early May. Application of 4.5 l /ha in the 3rd week of May and application of this low rate in the 2nd week in June also gave large herbage yields but the remaining treatments were only slightly better than or slightly below the yield obtained in control plots (Table 17).

Table 17: The effect of time and rate of application of seaweed extract on silage yield (1993).

Treatment	Yield -(t/ha)
	Site 6
No spray	21.9
T1R1	20.9
T2R1	24.1
T3R1	23.6
T1R2	21.5
T2R2	21.7
T3R2	18.8
T1R3	24.9
T2R3	22.4
T3R3	19.9
S. E. (df=27)	1.53
Extract average	21.98

Effect of time of application of extract type on tuber yield of potatoes.

This experiment was carried out at Site 14. Three extracts were evaluated in the potato crop at three times of application. The results are shown in Table 18. The treatments were applied when the potatoes were fully emerged and at 2 week intervals thereafter. All treatments gave an increase in the tuber yield compared with the control. The largest yield was obtained with Extract 5 when applied at two weeks following full emergence. Extract 5 gave a slightly better tuber yield compared with Extracts 3 and 4 irrespective of time of application. Extract 4 gave the lowest average tuber yield of all the three extracts.

Table 18: The effect of time of application of extract type on tuber yield of potatoes.

Treatment	Tuber Yield (t/ha)
	Site 7
No seaweed	33.7
E3R1	35.9
E4R1	34.5
E5R1	36.9
E3R2	35.9
E4R2	36.2
E5R2	37.7
E3R3	36.4
E4R3	35.9
E5R3	36.5
S.E.(df=27)	1.528
Extracts average	36.2

Effect of type and rate of application of seaweed extract type on tuber yield of potatoes.

The effect of type and rate of seaweed extract on potato yields was evaluated at Site 15. The three extracts which were evaluated were Extract 3, 4 and 5 and the rates of application were 4.5 l, 9.0 l and 18.0 l/ha. The extracts were applied when the potatoes were fully emerged. In this experiment Extract 5 gave the lowest tuber yield and Extract 3 gave the largest tuber yield. Extract 4 when applied at 4.5 l/ha also gave large tuber yield (Table 19).

Table 19: The effect of rate of application of extract type on tuber yield of potatoes

Treatment	Tuber Yield (t/ha)
	Site 14
No seaweed	34.9
E3R1	38.1
E4R1	38.2
E5R1	35.6
E3R2	37.9
E4R2	36.8
E5R2	34.9
E3R3	36.0
E4R3	33.5
E5R3	33.5
S. E. (df=27)	2.21
extract average	36.1

PART III. Farm Future: User -Trials Programme in the United Kingdom

1. Introduction

The trials were carried out on a range of sites in Scotland and England. Most sites had been used for field trials during the previous growing seasons. The three separate formulations were used in replicated trials using a randomised block design. The effects of the seaweed extracts were evaluated by means of recording; plant development differences, disease and pest infestation, yield, components of yield and quality parameters.

2. The Experimental Sites

Five locations were used for trials over the 1991-93 programme (Table 20).

Systems were conventional agriculture (con), biodynamic (BD), or organic.

Table 20. Sites used in Farm Future Trials

Farm	Location	System
Jamesfield Farm	Newburgh, Fife	BD/con
Charlesfield Farm	St Boswells, Borders	Conventional
Addiston Farm	Lander Berwickshire	Organic
Gala Estate Farms	Galashiels, Borders	Organic
Murtle Estate	Bieldside, Aberdeen	BD

3. Experimental Methods

Initial trials in 1991 used mainly one extract (known in subsequent trials as extract 2) and in 1992 three extracts were screened - formulations 1 to 3. In 1993, attention focused on a single extract, Formulation 3, which was tested in all trials and in addition two other formulations - Formulations 4 and 5 were applied to potatoes. The three formulations of seaweed extract plus water control were applied at 1:50 dilution (9 L/Ha in 450 L/Ha). A Cooper Pegler 15 L knapsack sprayer plus 3 jet boom was used for extract application. Three applications of extract were applied in all trials. The experiments were set up using a randomised block design with four blocks.

4. Results

Spring Oats Trials (1992)

Yields of organically grown oats (Dula) were significantly increased with the use of seaweed extracts (Table 21). In both trials the number of ears/sq m and grains/ear were increased with use of all three formulations. 1000 grain weight was also increased with the exception of Formulation 1 in Trial 3. In both trials the highest yields occurred with Formulation 3. Mildew levels were not altered with use of seaweed extract.

Table 21. Organically grown spring oats (Dula) at Jamesfield (1992)

Treatments	Yield t/ha	Ears sq. metre	Grains/ear	1000 grain (g)
Trial 3.				
1	2.75	154	38.2	34.8
2	2.95	159	39.2	47.4
3	3.35	164	40.7	50.0
Control	2.39	146	35.5	45.9
S t. error	0.16			
Trial 4				
1	2.56	134	38.0	50.2
2	2.67	136	39.7	50.5
3	2.88	145	39.5	50.6
Control	2.23	125	37.7	47.4
St. error	0.08			

Extract average = 2.86; control average = 2.31

Spring Oats (1993)

Yields of organically grown oats were increased with the use of seaweed extracts in three out of four trials. The exception was trial 12 in which a reduction in yield occurred, due to a heavy infestation of vermin leading to unreliable results. Nitrogen levels and % dry matter were unaffected by the use of seaweed extract.

Table 22. Spring Oats Trials (1993)

Trial	Treatment	Yield t/ha	Ears/m2	Grains/ear	1000 grain (g)	Nitrogen %	Dry Matter %
3*	Control	2.69	225	29.6	39.4	1.33	89.0
	Seaweed	4.1	265	38.3	40.7	1.3	89.1
	St. error	0.24					
4*	Control	2.8	200.5	34.5	38.7	1.26	88.7
	Seaweed	2.9	180	41.8	40.1	1.29	88.9
	St. error	0.26					
11#	Control	2.29	308.5	20.25	36.7	1.07	89
	Seaweed	2.53	322.5	21.05	37.5	1.08	88
	St. error	0.38					

* Jamesfield (Dula) : extract average = 3.50; controls average = 2.75

Hollybush (high weed level)

Winter Wheat (1993)

Yields of winter wheat (Mercia) grown at Jamesfield, a high yielding organic site, were increased with the use of seaweed extract (Table 23). Although the results in these trials were not statistically significant (P=0.05). The increases occurred over all the components of yield including an increase in ears/m2, grains per ear and 1000 grain weight. Nitrogen levels were slightly raised at the organic site and slightly lower at the conventional site.

Table 23. Winter Wheat Trials (1993)

Trial	Treatment	Yield t/ha	Ears/m2	Grains/ear	1000 grain (g)	Nitrogen %	Dry Matter %
1	Control	8.28	536.0	31.5	49.2	1.60	89.2
	Seaweed	10.31	556.0	35.7	52.0	1.67	89.5
	St. error	0.70					
2	Control	7.96	496.0	31.5	49.7	1.56	89.7
	Seaweed	9.32	498.0	35.6	52.5	1.58	90.7
	St. error	0.76					
5	Control	5.7	452.0	28.3	45.5	1.34	89.0
	Seaweed	5.3	440.5	28.0	42.9	1.33	89.0
	St. error	0.38					
6	Control	3.4	310.5	25.9	43.1	1.27	89.0
	Seaweed	3.3	295.5	27.3	40.6	1.1.	89.0
	St. error	0.2					

Trials 1 and 2 on organically grown winter wheat (Mercia) at Jamesfield. Extract average = 9.80; controls average = 8.12

Trials 5 and 6 on conventionally grown winter wheat at Charlesfield. There were no significant differences in these trials.

Spring Barley (1993)

Four barley trials were conducted at two sites, Charlesfield and Addiston. In all trials yields of barley were increased with the use of seaweed extract. Trials 9 and 10 of organically grown barley at Addiston had statistically significant (P=0.05) increases in yield. An increase in the number of ears/m2 was responsible for the majority of the increase in yield. Levels of nitrogen and % Dry matter remained relatively constant.

Table 24. Spring Barley Trials (1993)

Trial	Treatment	Yield t/ha	Ears/m2	Grains/ear	1000 grain(g)	Nitrogen %	Dry matter %
7	Control	7.48	691.0	21.0	51.4	1.32	90
	Seaweed	7.21	619.5	22.5	51.7	1.32	90
	St. error	0.78					
8	Control	6.27	566.5	21.6	51.3	1.30	89
	Seaweed	7.01	639.0	21.3	51.6	1.33	89
	St. error	0.40					
9	Control	6.30	594.5	20.0	53.0	1.41	85.8
	Seaweed	7.40	637.5	21.2	54.6	1.44	86.2
	St. error	0.33					
10	Control	6.22	601.5	19.7	52.5	1.4	88.1
	Seaweed	7.25	643.0	20.8	54.4	1.5	87.6
	St. error	0.05					

Trials 7 and 8 - conventionally grown spring barley - Charlesfield no increase

Trials 9 and 10 - organically grown spring barley at Addison, seaweed gave significant improvement in yield
Extract average = 7.33; controls average = 6.26

Lettuce

1992 Trials

Fresh weight of lettuce cultivars Liitle Gem and Iceburg were significantly increased with use of all three seaweed extracts (Table 25), although in both trials formulation 1 caused the greatest increase in yield. Dry matter was increased slightly in Little Gem and reduced with Iceburg. Protein levels were estimated only for Little Gem and there were slight increases in Formulations 1 and 2.

Table 25. Organically grown lettuce at Jamesfield (1992)

Treatments	Cultivar	Yield (kg / plot)	Dry matter %	Protein
Trial 5.	Little Gem			
1		2.63	5.1	20.5
2		2.14	5.5	20.8
3		2.46	5.1	18.7
Control		1.81	5.6	19.1
St. error		0.16		
Trial 6	Iceberg			
1		4.22	3.3	
2		3.92	3.3	
3		3.92	3.2	
Control		3.53	3.1	
S t. error		0.21		

Little Gem : extract average = 2.41; control average = 1.81
Iceberg : extract average = 4.02; controls average = 3.53

1993 Trials

There were slight increases in the fresh head weight of lettuce cultivars Little Gem and Iceberg (Table 26). Problems occurred during the course of the trials.

Table 26. Lettuce Trials (1993)

Trial	Cultivar	Treatment	Head weight (kg) *
13	Little Gem	Control	0.19
		Seaweed	0.21
		St. error	0.02
14	Iceberg	Control	0.315
		Seaweed	0.327
		St. error	0.03

Trials were conducted at Jamesfield.

* dry matter

Potatoes

In these trials Formulation 3 caused a slight increase in yield only in trials 15 and 16, while Formulations 4 and 5 caused the greatest increases in yield (Table 27). This low response of potatoes to Formulation 3 is similar to the previous year's results. Formulations 4 and 5 were developed specifically for work on potatoes and the results from these trails are encouraging.

Table 27. Potato Trials (1993)

Trial	Cultivar	Treatment	Weight (t/ha)
15	Duke of York	Control	12.40
		Formulation 3	14.62
		Formulation 4	16.42
		Formulation 5	15.47
		St. error	na
16	Estima	Control	16.00
		Formulation 3	17.57
		Formulation 4	18.95
		Formulation 5	18.85
		St. error	na
17	Estima	Control	11.2
		Formulation 3	10.85
		Formulation 4	11.0
		Formulation 5	11.57
		St. error	na

Duke of York: extract average 15.5
Estima(trial 16): extract average = 18.46
Estima (trial 17): extract average = 11.14

Figure 1. Seaweed Extract Effect (Teagasc Trials)
- Cereals -

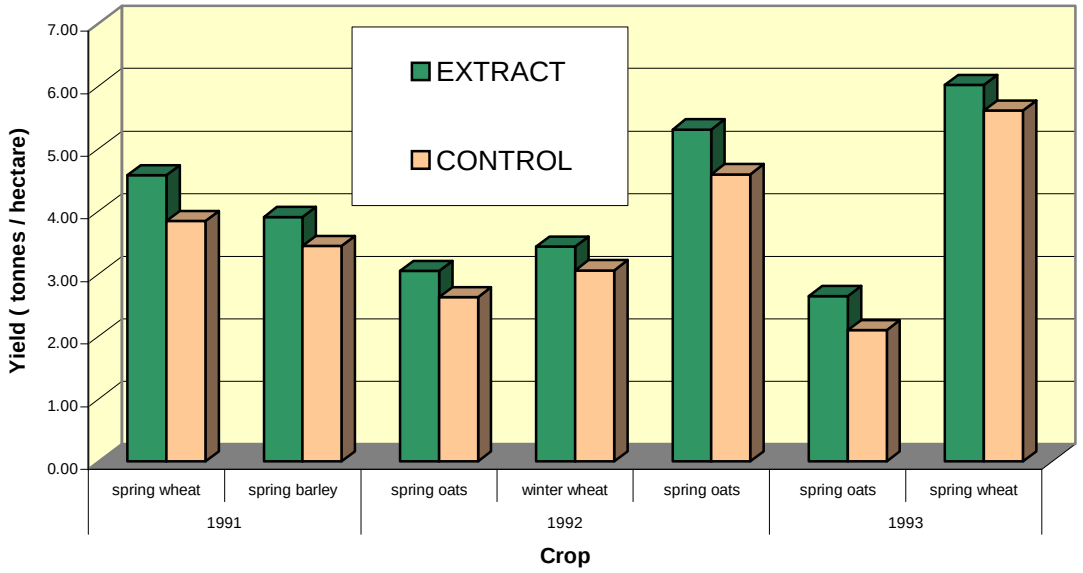

Figure 2. Seaweed Extract Effect (Teagasc Trials)
- Root and Veg -

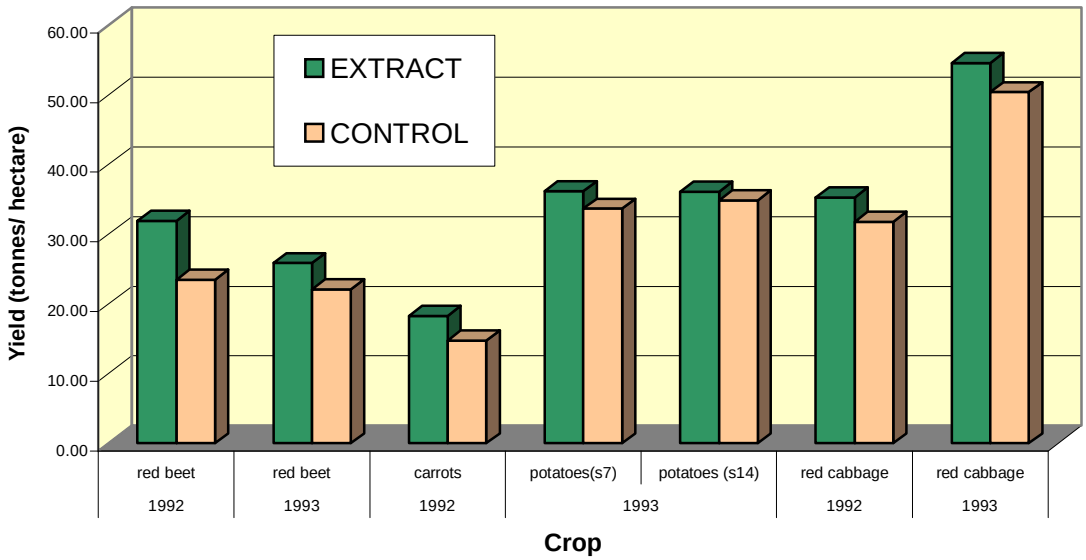

Figure 3. Seaweed Extract Effect (Farm Future Trials)
- cereals -