Project title:	**Heathers – A study of potential improvements in nutrition**
Project number:	**HNS 96a**
Project leader:	**Dr Jim Monaghan** **HRI-Efford** **Lymington** **Hants. SO41 0LZ**
Report:	**Annual report (August 31st 2001)**
Previous reports:	**None**
Key workers:	**Jim Monaghan - Project leader** **Carrie Hawes – Scientific support**
Location:	**HRI-Efford**
Project co-ordinators:	**Mr David Edge** **Forest Edge Nursery** **Woodlands** **Wimborne** **Dorset** **BH21 8LJ**
Date commenced:	**1st March 2000**
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Key words:	**controlled release fertilisers, Heathers, container grown**

CONTENTS

Practical Section for Growers

Background and Objectives

An HDC funded study (HNS 96) of different CRF rates and products with Heather cultivars was undertaken in the 1998/99 growing season. Rates of application were studied using the industry standard, Osmocote Plus 12-14 (Autumn) with each cultivar at 1.0, 1.5 and 2.0 kg m^{-3}. Surprisingly, in light of the rates used on nurseries, no benefit was observed at rates above 1.5 kg m^{-3} with moderate and vigorous cultivars; and with *Calluna vulgaris* 'Peter Sparkes' plants of adequate quality were grown with 1.0 kg m^{-3}.

Of the other products studied at 1.5 kg m^{-3} only, Vitacote produced the best plants with all the cultivars studied. Whereas some of the salt sensitive plants died with Osmocote plus, no plant deaths occurred at the same rate of Vitacote. This finding was of particular interest – if one rate of CRF could produce quality plants of both vigorous and salt sensitive cultivars one mix could be prepared for most cultivars on a nursery saving preparation time and complication.

The work reported here is year 1 of a two-year project, following up the conclusions of HNS 96 and asking the following questions:

- What is the factor that allowed one rate of CRF to be used with a wide range of salt sensitivities?
- What is the most cost-effective CRF rate for a range of Heathers?

There are a number of explanations for the improved plant quality with Vitacote:
a) a coating of iron pigment
b) shorter longevity
c) higher N analysis

a) Iron nutrition
The possible role of the iron (Fe) pigment is an intriguing one. Physiological iron deficiency has been observed with ericaceous plants in a number of situations: when there is too much lime in the substrate; when the concentration of HCO^- in the irrigation water is too high i.e. hard water areas; when the levels of certain elements (e.g. copper, manganese, zinc, calcium etc.) are too high; and in a low K : high P environment.

One way to limit Fe deficiency is acidification of hard water supplies (through the addition of concentrated nitric acid). This has a two-fold effect, limiting the increase in the pH of the growing media over time and supplying a small additional supply of nitrogen (~ 20 mg/l).

However, if the addition of Fe chelate in the initial potting mix with CRF proved effective this could provide a low cost, and safe, alternative to acid dosing irrigation systems.

b) CRF longevity

The Vitacote granule has the same longevity as Multicote 8, a CRF that has been shown to be capable of use as a 12-14 month product. However, it is accepted that Multicote 8 has a shorter longevity than Osmocote 12-14 or even Multicote 12. The comparison between Multicote 8, Vitacote and Osmocote Plus 12-14 (Autumn) reported here has allowed us to look at any benefit with a shorter longevity CRF.

c) N analysis

Vitacote also had a higher N analysis than Osmocote Plus 12-14 (Autumn). Whether this had any effect will be studied by analysing the amount of N in the plants, to show how much N had been supplied from the different CRFs over the growth of the plant (this data will be presented in the final report).

Finally, by looking at CRFs across a range of rates it is possible to see which rate of each CRF most efficiently produces quality plants – allowing application of the rate of CRF required by the plant, reducing wastage.

Summary of Results

These experiments were undertaken for one year only. Consequently, any findings are for the conditions *under which the experiment was carried out*. To a certain extent, extrapolation to other years is possible, but must be made with a full understanding of the conditions studied in this work. Additionally, account must be made of irrigation system, incorporation of base fertiliser and geographical location if they differ from those in this study.

Overall, the growing year 2000-01 was unusually wet and warm in December and February and higher than normal amounts of nutrients leached from the granules, especially during February. This has had a major effect on the trial, limiting differences between treatments and lessening the effect of acid dosing, as this could only be effectively be applied during the dry periods. This explains why there was little consistent difference in plants irrigated either with mains or acidified water. The second year of this work will be moved under protection to prevent leaching and loss of nutrients in the eventuality of another wet year.

In contrast to HNS 96, *by the end of the trial* Vitacote was not consistently better than any of the CRFs studied, although Vitacote produced larger plants of ‘Mrs D F Maxwell’ and significantly more flowering in ‘Mrs D F Maxwell’ and ‘King George’. However, plants responded to CRF treatment prior to the heavy winter rainfall, with Vitacote producing plants significantly larger than one or more treatments with all cultivars, suggesting that the lack of clear data by the end of the trial *was* due to leaching of nutrients from the growing medium. Interestingly, at the first record, acidification of the growing medium removed the benefit of Vitacote at lower rates of CRF, i.e. other CRFs performed as well as Vitacote when the Fe available to the plants increased with acidification of the growing medium.

The proportion of plant deaths at the highest rate (2.0 kg m^{-3}) was lower than HNS 96, which may be due to increased leaching of nutrients due to the heavy rainfall (as highlighted above). Vitacote was associated with a similar number of dead plants to Osmocote Plus (Autumn) 12-14, again, in contrast to HNS 96 where Vitacote was noted for the reduced plant losses compared to Osmocote plus12-14 (Autumn).

By the end of the trial Multicote 8, and to a lesser extent Multicote 8 & Fe, produced plants that responded more similarly to plants grown with Vitacote. Hence, Vitacote was producing the same plant responses as a Multicote 8 granule and the reduced longevity of the granule may explain the different responses previously observed. This could also contribute towards the lack of significant difference in the trial. Vitacote and the two Multicote 8 CRF treatments were essentially the same treatment. This trend was not the same for ‘Peter Sparkes’ where the Fe appeared to be the important factor in Vitacote’s responses.

In general, and for a wet year, a rate of 1.5 kg m^{-3} should be sufficient for most Heathers. Interestingly, the size score and dry weight of ‘King George’ benefited from additional rates of Vitacote; an unexpected finding as *Erica carnea* ‘King George’ is a salt sensitive cultivar.

The individual cultivars responded as follows:

***Erica carnea* ‘King George’**

Overall, Vitacote produced average sized plants and was notable in producing significantly more flowering than the other CRFs. The optimum CRF rate for plant size was 1.5 kg m^{-3} for Multicote 8 & Fe and Osmocote 12-14; 2.0 kg m^{-3} for Vitacote and Multicote 8. A surprising conclusion as ‘King George’ was the most salt sensitive cultivar in the trial. However, there was no clear trend in dry weight as responses differed for each CRF, giving a confused picture. Vitacote

***Erica carnea* ‘Myretoun Ruby’**

Vitacote again produced average sized plants. Differences between CRFs were greatest at the lowest rate (1.0 kg m^{-3}) suggesting that it was excess nutrients that were being leached away by rain. The optimum rate of CRF for plant size was 1.5 kg m^{-3} for all CRFs. Dry weight was shown to increase with rate overall but as with ‘King George’ the data were variable and the optimum CRF rate for dry weight was 2.0 kg m^{-3} for Multicote 8 and 1.5 kg m^{-3} for the other CRFs

***Calluna vulgaris* 'Peter Sparkes'**

Vitacote produced similar plants to the other treatments and no single CRF excelled. The optimum rate for plant size was 1.5 kg m^{-3} except for Osmocote 12-14 which required 2.0 kg m^{-3} probably as a result of the slower release rate of a 12-14 month product. Interestingly, the optimum rate for dry weight was 2.0 kg m^{-3} for all CRF treatments.

***Erica vagans* 'Mrs D F Maxwell'**

Vitacote performed well in both acidified and mains water and flowering was significantly increased with Vitacote. The optimum rate for plant size was 1.5 kg m^{-3} for all CRFs. However, the optimum CRF rate for dry weight was 1.5 kg m^{-3} for Multicote 8 and Osmocote 12-14; 2.0 kg m^{-3} for Multicote 8 & Fe and Vitacote

Conclusion

In conclusion, no clear trend was observed for CRF response by the end of the growing season, although differences were present at the first, autumn 2000, record. It is highly likely that the exceptionally wet weather affected the trial. By protecting the plants from rainfall over winter, the second (current) year will allow the initial questions raised in HNS 96 to be answered more conclusively.

Action Points/Practical and Financial Benefits

The conclusions of this first year are not clear enough to suggest comprehensive Action Points or Practical and Financial Benefits. However, taking the early season results the following can be considered:

- Incorporation of a slowly releasing iron source can benefit Heathers grown with mains irrigation

- Acidification of irrigation water removes some of the benefit observed in early growth with Vitacote

- Even in a wet year 1.5 kg m^{-3} CRF can produce quality plants

Science Section

Introduction

An HDC funded study (HNS 96) of different CRF rates and products with Heather cultivars was undertaken in the 1998/99 growing season. Rates of application were studied using the industry standard, Osmocote Plus 12-14 (Autumn) with each cultivar at 1.0, 1.5 and 2.0 kg m^{-3}. Surprisingly, in light of the rates used on nurseries, no benefit was observed at rates above 1.5 kg m^{-3} with moderate and vigorous cultivars; and with *Calluna vulgaris* 'Peter Sparkes' plants of adequate quality were grown with 1.0 kg m^{-3}.

Of the other products studied at 1.5 kg m^{-3} only, Vitacote produced the best plants with all the cultivars studied. Whereas some of the salt sensitive plants died with Osmocote plus, no plant deaths occurred at the same rate of Vitacote. This finding was of particular interest – if one rate of CRF could produce quality plants of both vigorous and salt sensitive cultivars one mix could be prepared for most cultivars on a nursery saving preparation time and complication.

There are a number of explanations for the improved plant quality with Vitacote:

- a coating of iron pigment
- shorter longevity
- higher N analysis

The results of HNS 96 suggest that it is unlikely, though not impossible, that the improved plant growth observed with Vitacote was due to longevity or analysis, as plants did not respond to increased rates of Osmocote.

The possible role of the iron (Fe) pigment is an intriguing one. Physiological iron deficiency has been observed with ericaceous plants in a number of situations: when there is too much lime in the substrate; when the concentration of HCO^- in the irrigation water is too high i.e. hard water areas; when the levels of certain elements (e.g. copper, manganese, zinc, calcium etc.) are too high; and in a low K : high P environment.

It has been claimed that iron chelates "deepen the colour of many of the blue green conifers... [and]… are also used to produce a richer green in various kinds of nursery stock." (Anon, 1980). Lime-induced chlorosis / iron deficiency is a major problem in world agriculture and as such a wealth of data is available on the role of iron in plant growth and development. Most of this work concentrates on the mechanisms of calcifugy and nutrient accumulation rather than the means to ameliorate symptoms. However, it has been known for some time that the addition of iron salts to the leaves of plants (Gris, 1844), and the soil application of chelated iron (Bould, 1955) can overcome lime-induced chlorosis.

A MAFF funded project carried out from 1996-98 at HRI-East Malling and Efford, and the University of Sussex, looked at countering the aversion of hardy ornamentals to chalk soils (OCS 945C). The mechanisms underlying lime chlorosis were studied in *Erica*, at the University of Sussex, and it was demonstrated that the application to the leaves of excess artificial chelates (eg EDTA, EGGHA) led to partial relief of lime chlorosis and could be accounted for by a small proportion entering the leaf cells intact. However, root addition was not studied.

Acidification of hard water supplies (through the addition of concentrated nitric acid) has been shown to improve the growth of both *Erica* and *Calluna* species (Scott and King, 1987), through a combination of limiting the increase in the pH of the growing media over time, and supplying a small additional supply of nitrogen (~ 20 mg/l). However, if the addition of Fe were shown to be of advantage, especially with higher pH water sources, then it could provide a low cost, safe alternative to acid dosing irrigation systems.

This study aims to establish whether improvement in the quality of heather growth can be achieved through adjustment in

- iron supply,
- nitrogen supply
- or CRF longevity,
- and whether this improvement can be maintained across a range of irrigation water pH.

Materials and Methods

The experiment was carried out using water extracted from the mains supply (pH 7.8-8.2) and acidified water (pH 5.6-6.0). All nutrition treatments were examined under both irrigation regimes.

Table 2. Experimental treatments

Treatment	Product		Fe EDTA
		kg/m^3	g/m^{-3}
1	Vitacote	1.0	
2	"	1.5	
3	"	2.0	
4	Multicote 8	1.0	
5	"	1.5	
6	"	2.0	
7	Multicote 8 & Fe-EDTA	1.0	40
8	"	1.5	60
9	"	2.0	80
10	Osmocote Plus 12-14 (Autumn)	1.0	
11	"	1.5	
12	"	2.0	

Table 3. Analysis of products involved in experiment.

Product	Analysis	UK Supplier
Multicote 8	18:6:12 (traces)	Hi-Chem (UK) Ltd
Osmocote Plus 12-14 (Autumn)	15+9+11+traces	Scotts UK Ltd
Vitacote	18-6-12+T.E.	Vitax Ltd.
Librel Fe-Lo	13.2% Fe	Ciba

Growing System

Plants were grown outdoors on sandbeds covered with a double layer of Mypex, to prevent capillary action, with overhead irrigation.

Growing media 100% Irish Premium peat
1.0 kg/m^3 Mg Lime
750 g/m^3 suSCon green

***Start material**:* Plugs potted-on into 9cm containers (Week 21)

Species: *Erica carnea* 'King George' - Winter flowering, salt sensitive
Erica carnea 'Myretoun Ruby' – Winter flowering, moderate
C*alluna vulgaris* 'Peter Sparkes' – Late Autumn flowering, vigorous
Erica vagans 'Mrs D F Maxwell' – Summer flowering, vigorous

Potting date: Week 21 (22/5/00)

***Design**:* Randomised block with three replicates.

Plot size:
20 plants per plot, 9 recorded and 11 guards.
20 plants x 3 reps x 12 nutrient treatments x 2 irrigation pH = 1440 plants/species

Pest and Disease: Imidacloprid (Intercept) drench, routine fungicide programme: prochloraz (Octave), dichlofluanid (Elvaron), tolclofos-methyl (Basilex)

Assessments

Plants were assessed in October 2000 and after the first flush of growth, in June 2001. The variables recorded differed with species, as appropriate, and are outlined in the results section.

Scoring of size and flowering was subjective; made by visual comparison against selected standards each time. Photographs and measurements of these standards were taken.

Standard plants were selected for each assessed variable as follows: 6 plants displaying the full range of the variable were chosen from within the experimental plots and replaced into the body of plants after all plants had been scored against them. These plants were termed standard 0 to standard 5, with the variable the least for 0 and the greatest for 5; e.g. for size, 0 was the smallest plant and standard 5 was the largest plant. The standards were grown under the same condition as all the recorded plants and were measured and photographed before being replaced. Standards were selected anew each time plants were scored.

Above ground dry weight was recorded for half of all recorded plants (n=6) by destructive sampling after the spring flush of growth.

Nutrient analysis:

At potting, Autumn and Spring, 50 granules of each CRF treatment were collected, dried, ground up and analysed for available major and micro-nutrients (HRI-Wellesbourne). Samples at potting were taken directly from the bag, whereas the final sample was bulked across replicates of one species only, at one rate. Foliage nutrient analysis of available major and micro-nutrients (HRI-Wellesbourne) were undertaken on destructive plant samples at the start of the trial (from 5 plants per species) and the end of the trial for each species at one CRF rate (n=3), to allow actual nutrient uptake, to be estimated

Photographs Photographs were taken as appropriate throughout trial.

Statistics

Statistical analysis of all variables was carried out by the Biometric department at HRI-East Malling. Statistical analysis can be applied to data derived from a scoring system. There are many examples of this in the literature, especially within microbiology. Recording 5-6 plants per plot leads to a normally distributed population around the mean score value. Consequently, this score was used in ANOVA to derive significance of treatment responses. Least significant differences ($LSD_{(0.05)}$) were calculated to aid interpretation of the data.

Results

Weather data

HRI-Efford

The growing season was unusually wet, especially from the end of summer until March (see Table 4). Rainfall was frequent and heavy with week 40 – 52 having a weekly averages exceeding 10mm rain.

The highest temperatures were recorded week 35 in 2000 and week 20 and 22 in 2001. Over winter there were particularly cold periods in week 1 and 3, and an unusually cold fortnight in March (wk 10 & 11).

Table 4. Monthly average rainfall, maximum and minimum temperatures at HRI-Efford as a percentage of the 49 year monthly average.

2000	May	June	July	Aug	Sept	Oct	Nov	Dec
first full week no.	*19*	*23*	*28*	*32*	*36*	*41*	*45*	*49*
Rainfall (mm)	173	50	72	54	154	191	222	167
Max °C	109	102	98	105	105	-	105	110
Min °C	120	111	98	97	115	106	108	156

2001	Jan	Feb	March	April	May
first full week no.	*1*	*5*	*9*	*14*	*18*
Rainfall (mm)	115	147	94	119	107
Max °C	108	124	121	101	103
Min °C	95	110	119	120	100

***Erica carnea* 'King George'**

Autumn 2000

There was no main effect of irrigation water pH on size score at this stage of growth. Overall, plant size increased with rate of CRF applied for all products but Osmocote, which produced plants of similar size at all three rates.

Of the 4 products, Vitacote produced the largest plants when mains irrigated, significantly larger than Osmocote at 2.0 kg m^{-3}, and Multicote 8 and Multicote 8 & Fe at 1.0 kg m^{-3} (Fig. 1a). No significant differences were observed between CRFs when irrigated with acidified water (Fig 1b).

CRF and rate of application had main effects on flowering. Vitacote produced above average flower score for all three rates, and significantly more flowers at 2.0 kg m^{-3} (Table 5). Interestingly, at the highest rate, flowering was reduced in the other CRF products.

Summer 2001

There was a significant main effect of pH of irrigation water by spring. Plants receiving acidified water were larger and darker than those irrigated with mains water.

When CRFs were compared, mains irrigated treatments responded similarly (Fig 2a). However, differences were observed at the highest rate, with Vitacote producing plants significantly larger than Osmocote 12-14. With acidified irrigation Vitacote produced plants of a smaller size, significantly so at 1.5 kg m^{-3} (Fig 2b). Little benefit was observed with increased CRF above 1.0 kg m^{-3} for Vitacote or Osmocote 12-14

Dry weight increased significantly with rate of application regardless of CRF (Table 5).

Overall

- Vitacote produced average plants with mains water and below average with acidified water
- Multicote 8 performed well with acidified water
- Optimum rate for size was 1.5 kg m^{-3} for Multicote 8 & Fe and Osmocote 12-14; 2.0 kg m^{-3} for Vitacote and Multicote 8
- Flowering was significantly higher with Vitacote
- Dry weight response differed for CRFs
- Optimum rate for dry weight was 2.0 kg m^{-3} for Vitacote and 1.5 kg m^{-3} for the other CRFs

Figure 1. ***Erica carnea*** **'King George'**
Autumn 2000; HRI-Efford
Size score

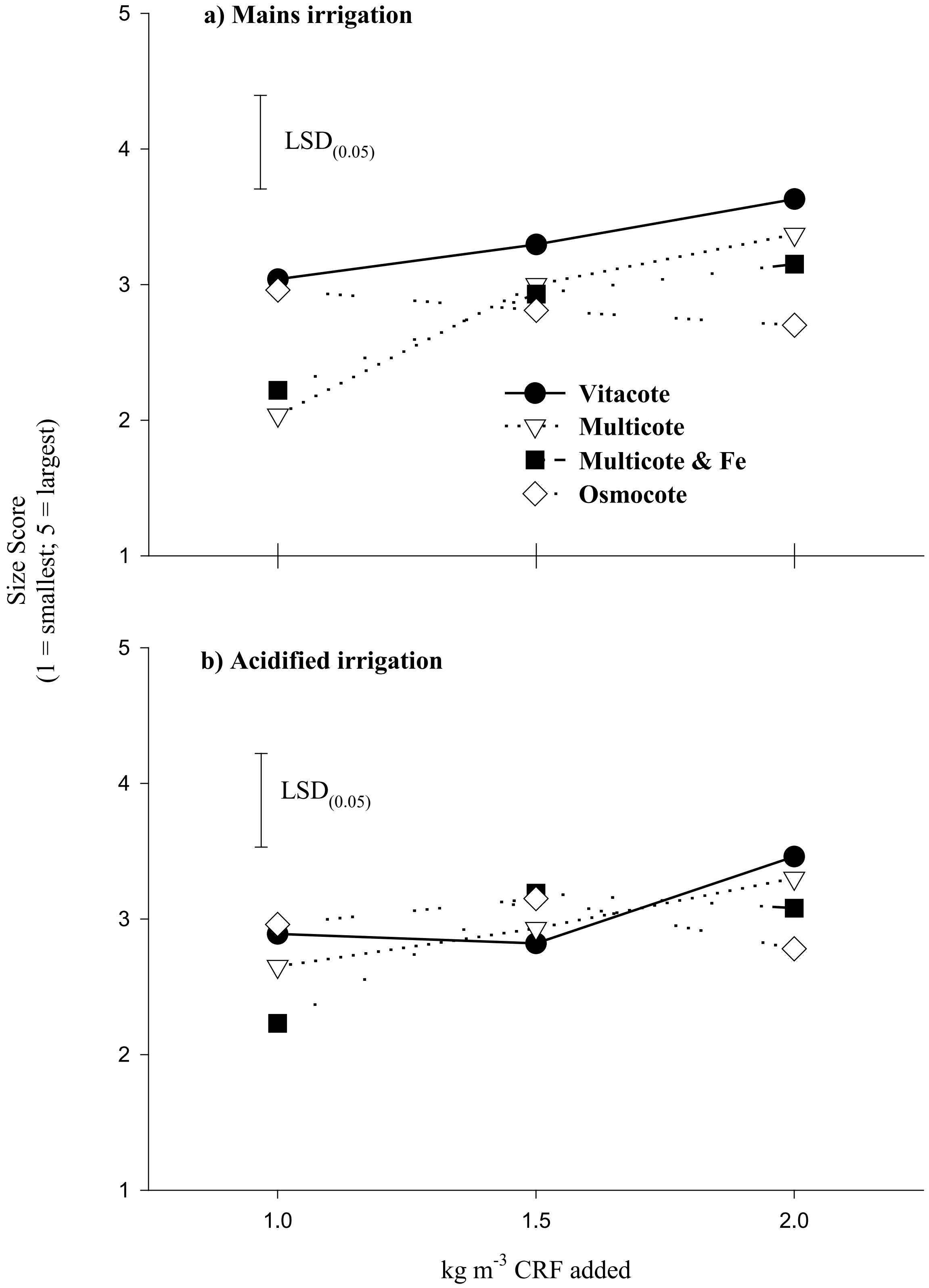

Figure 2. ***Erica carnea*** **'King George'**
Summer 2001; HRI-Efford
Size score

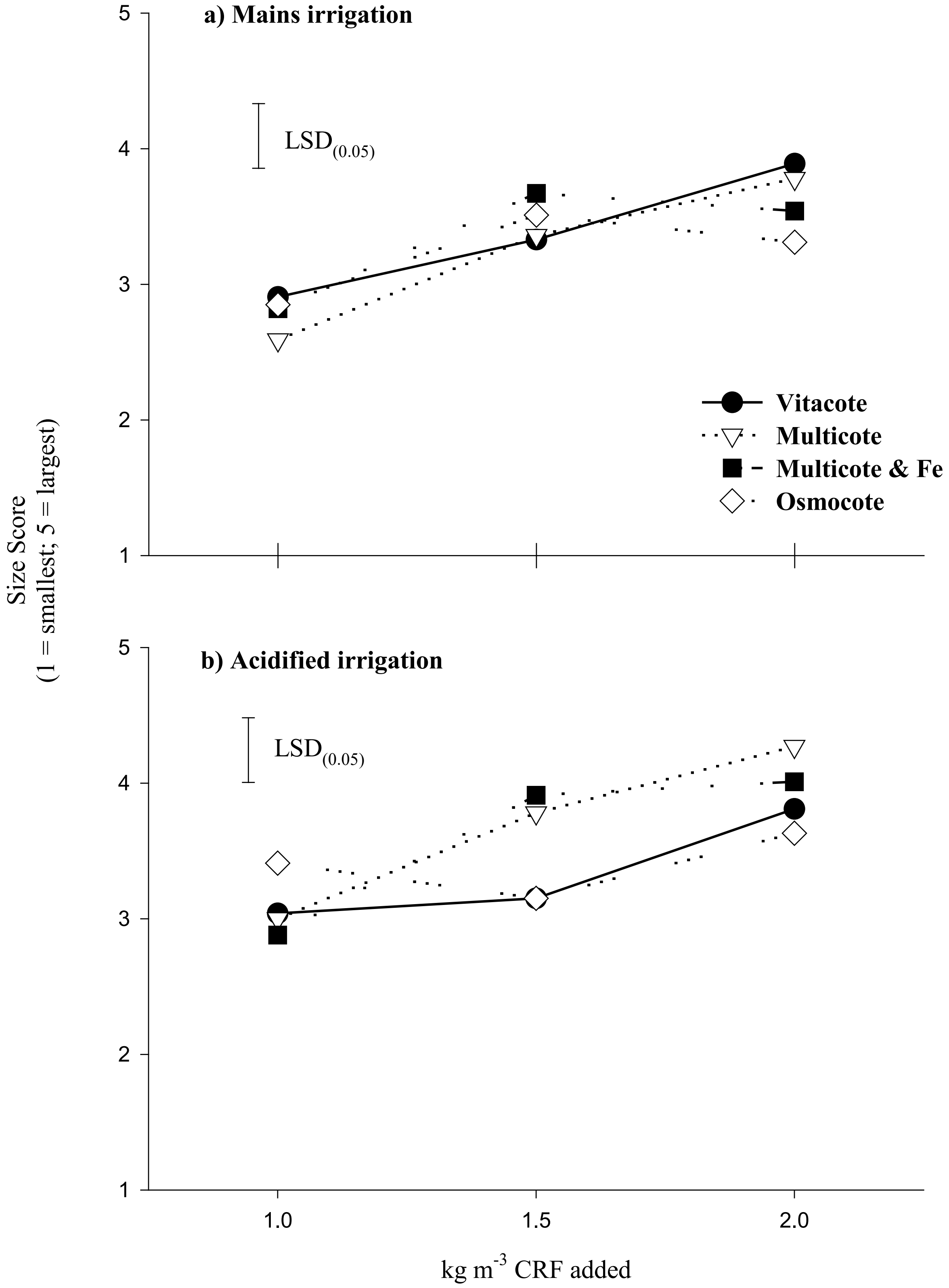

Table 5. Erica carnea* 'King George', *HRI-Efford 2000-01
Flower score and above ground dry weight at end of trial.
(As irrigation water pH had no effect data is pooled from both treatments.)

	Flower score Winter 2000 (1 = least; 5 = most)			Plant dry weight (g) Summer 2001 (g/3 plants)		
Fertiliser/Rate	**1.0**	**1.5**	**2.0**	**1.0**	**1.5**	**2.0**
Vitacote	3.54	4.15	4.25	2.85	3.30	4.32
Multicote8	2.27	3.58	3.28	2.64	3.81	4.43
Multicote8 & Fe	2.73	3.77	3.47	2.83	3.72	3.79
Osmocote	3.48	3.76	3.15	2.85	3.96	3.64
Grand mean		3.45			3.51	
d.f.		46			46	
l.s.d.		0.691			0.753	

***Erica carnea* 'Myretoun Ruby'**

Autumn 2000

No main effect was observed for irrigation pH at this stage. Although significant interactions were observed between CRF and irrigation pH, no consistent response was apparent. Mains irrigated treatments differed greatest at the lowest rate (Fig 3a). Vitacote produced significantly larger plants than Multicote 8 & Fe at 1.0 kg m^{-3}, Multicote 8 at 1.5 kg m^{-3} and Osmocote 12-14 at 2.0 kg m^{-3}. With acidified irrigation Vitacote produced plants larger than all CRFs at both 1.0 and 2.0 kg m^{-3} (Fig 3b).

CRF and rate had significant effects on flowering, although as with the size score little pattern was evident (Table 6). Vitacote and Osmocote 12-14 produced significantly more flowers than Multicote 8 or Multicote 8 & Fe at 1.0 kg m^{-3}. However, at 2.0 kg m^{-3} Vitacote and Osmocote 12-14 were very different with Vitacote producing significantly more flowers than Osmocote 12-14, and Multicote 8 producing more flowers than Multicote 8 & Fe.

Summer 2001

As with the autumn records, no main effect was detected for the pH of irrigation water. With mains irrigation, Osmocote 12-14 produced larger plants than Vitacote and Multicote 8 & Fe at 1.0 kg m^{-3} (Fig 4a). However, this difference was not apparent at 2.0 kg m^{-3}.

No significant differences were observed for plant size with the treatments irrigated with the acidified water (Fig 4b).

Plant dry weight significantly differed with overall rate of CRF, regardless of product, increasing with rate applied (Table 6). Nevertheless, Multicote 8 at the highest rate of incorporation produced significantly greater dry weight than Multicote 8 & Fe.

Overall

- Vitacote produced average plants. CRF differences were greatest at lowest rate
- Optimum rate for size was 1.5 kg m^{-3} for all CRFs
- Dry weight increased with rate but data was variable
- Optimum rate for dry weight was 2.0 kg m^{-3} for Multicote 8 and 1.5 kg m^{-3} for the other CRFs

Figure 3. ***Erica carnea*** **'Myretoun Ruby'**
Autumn 2000; HRI-Efford
Size score

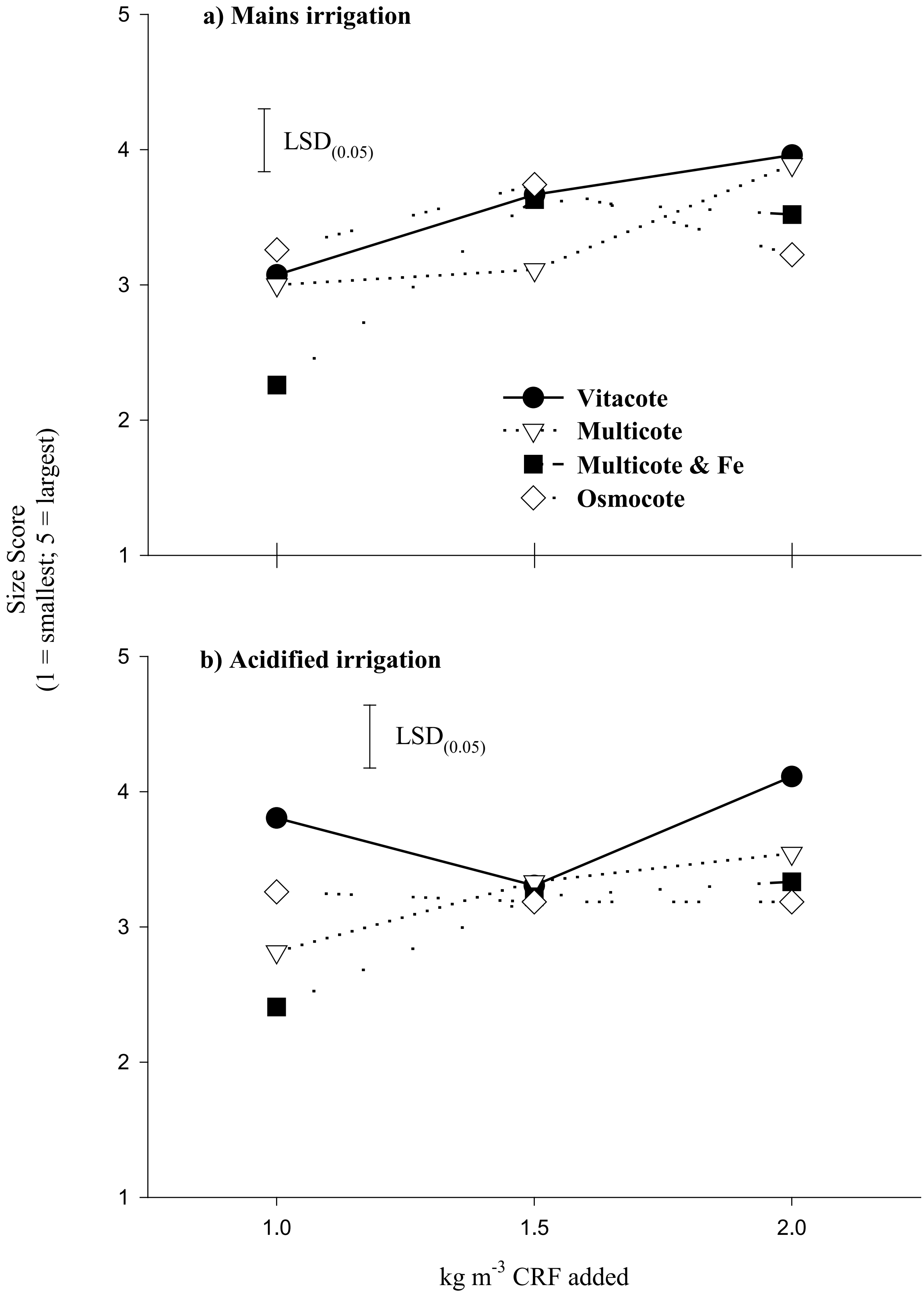

Figure 4. ***Erica carnea*** **'Myretoun Ruby'**
Summer 2001; HRI-Efford
Size score

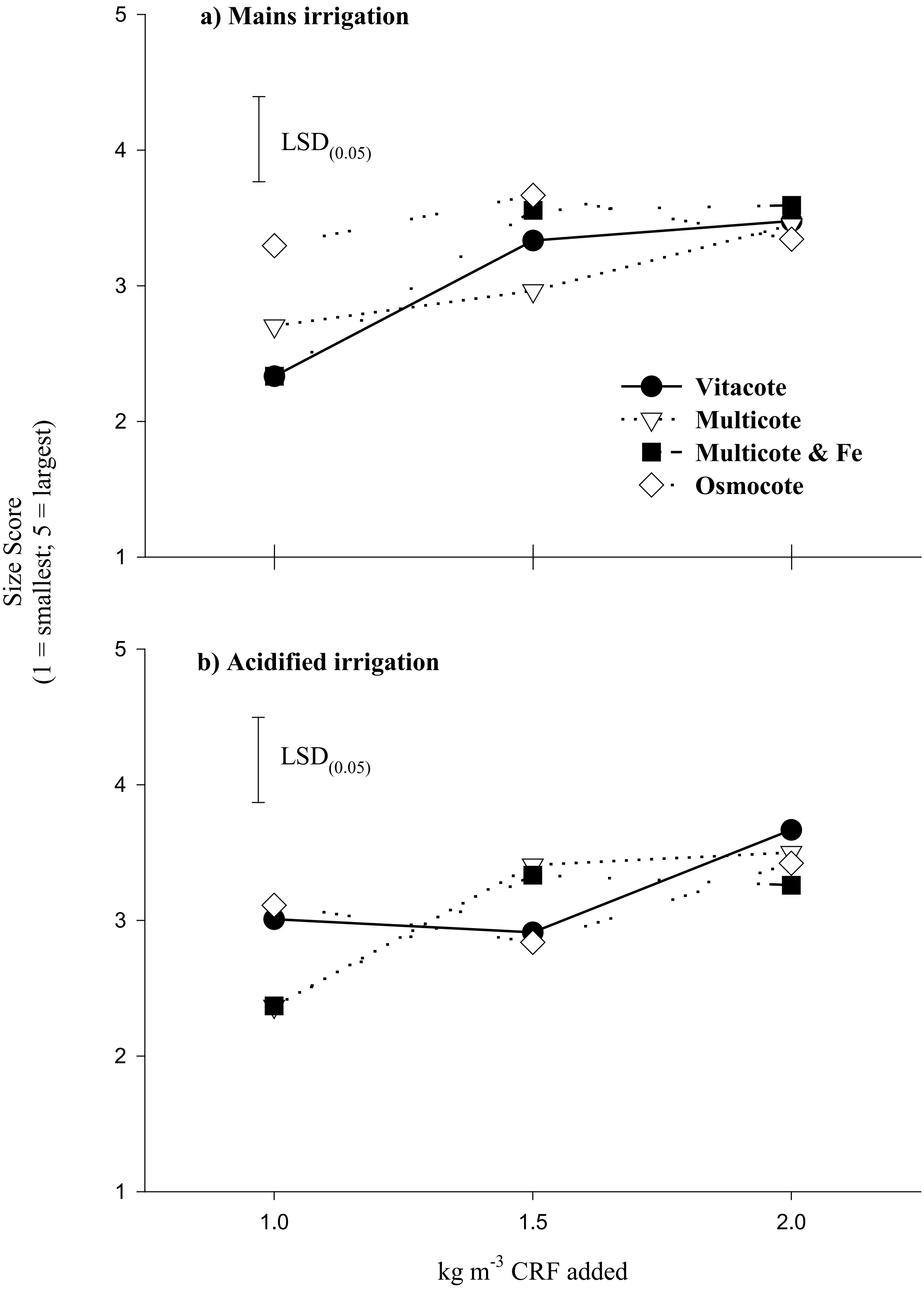

Table 6. Erica carnea* 'Myretoun Ruby', *HRI-Efford 2000-2001
Flower score and above ground dry weight at end of trial.
(As irrigation water pH had no effect data is pooled from both treatments.)

	Flower score Winter 2000 (1 = least; 5 = most)			Plant dry weight (g) Summer 2001 (g/3 plants)		
Fertiliser/Rate	**1.0**	**1.5**	**2.0**	**1.0**	**1.5**	**2.0**
Vitacote	3.21	2.84	3.72	3.67	4.46	4.95
Multicote8	2.17	2.76	3.63	3.71	4.50	5.72
Multicote8 & Fe	1.69	3.32	2.85	3.30	4.49	4.32
Osmocote	3.33	2.52	2.37	3.58	4.52	5.05
Grand mean		2.87			4.36	
d.f.		46			44	
l.s.d.		0.612			0.948	

C*alluna vulgaris* 'Peter Sparkes'

Autumn 2000

By autumn, mains irrigated plants were larger overall than plants receiving acidified water. With mains irrigation all CRFs at 1.0 kg m^{-3}produced plants significantly different from the other 3 products (Fig 5a). Osmocote 12-14 produced the largest plants. This difference was reduced at 1.5 kg m^{-3} and no significant difference was present at 2.0 kg m^{-3}. The treatments irrigated with acidified water were less variable (Fig 5b). Vitacote and Multicote 8 & Fe behaved similarly, and plants grown with Osmocote 12-14 did not respond to rate of incorporation.

Flowering differed with CRF and rate but no pattern was clear. The most flowers were recorded with Osmocote 12-14 at 1.0 kg m^{-3} (Table 7).

Summer 2001

By summer CRFs were producing plants of similar size at each rate and, overall, size increased with rate. Osmocote 12-14 produced unusually small plants at 1.5 kg m^{-3} compared to 1.0 and 2.0 kg m^{-3} regardless of pH of irrigation water (Fig 6a & b).

Dry weight showed clear response to rate of application of CRF regardless of product (Table 7). As with size score, Osmocote 12-14 at 1.5 kg m^{-3} produced significantly less dry weight than 1.0 or 2.0 kg m^{-3}.

Overall

- Vitacote produced similar plants to the other treatments. No CRF excelled.
- Optimum rate for size was 1.5 kg m^{-3} except Osmocote which required 2.0 kg m^{-3}
- No clear trend appeared for flowering
- Optimum rate for dry weight was 2.0 kg m^{-3}

Figure 5. ***Calluna vulgaris*** **'Peter Sparkes'**
Autumn 2000; HRI-Efford
Size score

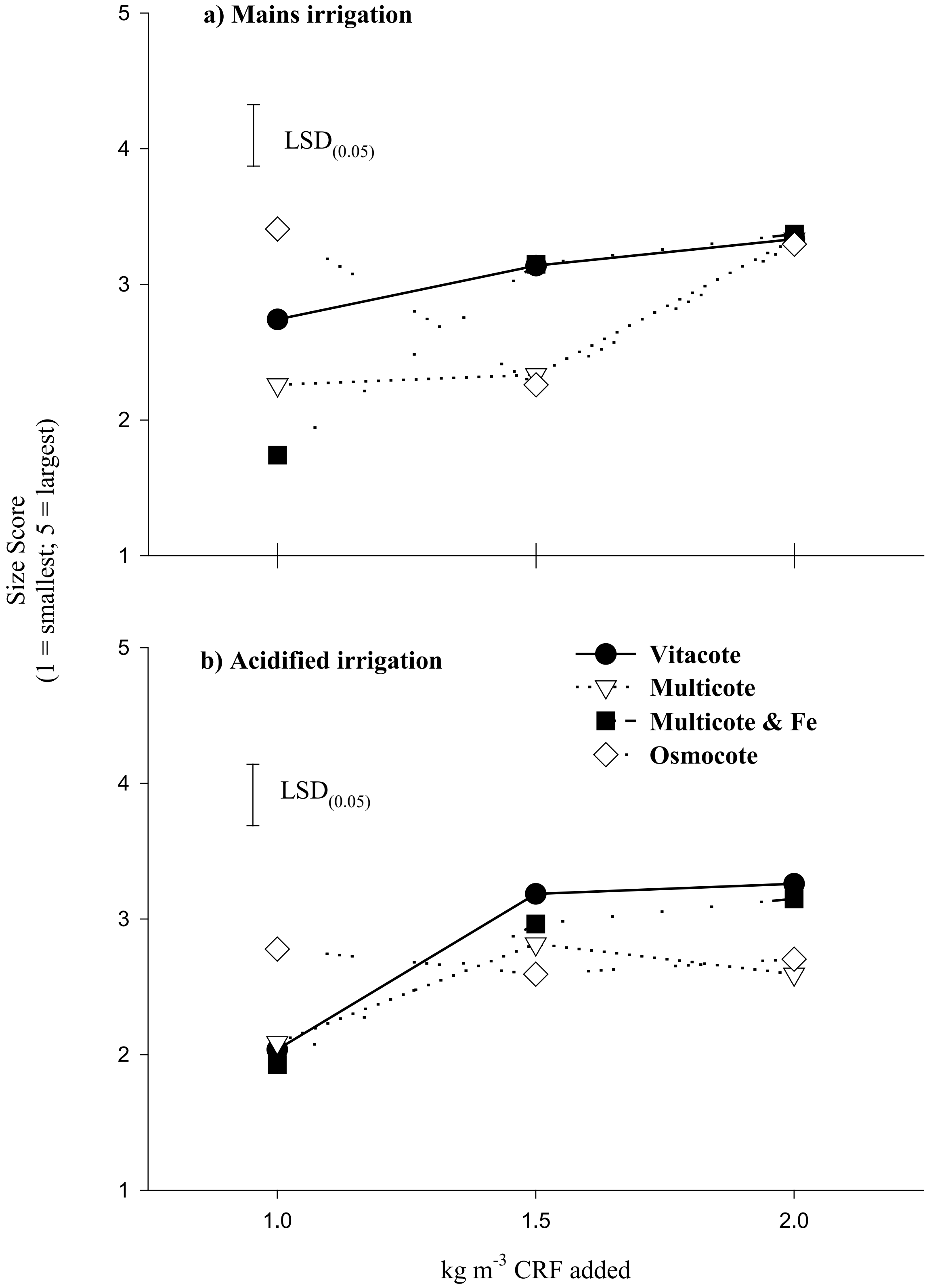

Figure 6. ***Calluna vulgaris*** **'Peter Sparkes'**
Summer 2001; HRI-Efford
Size score

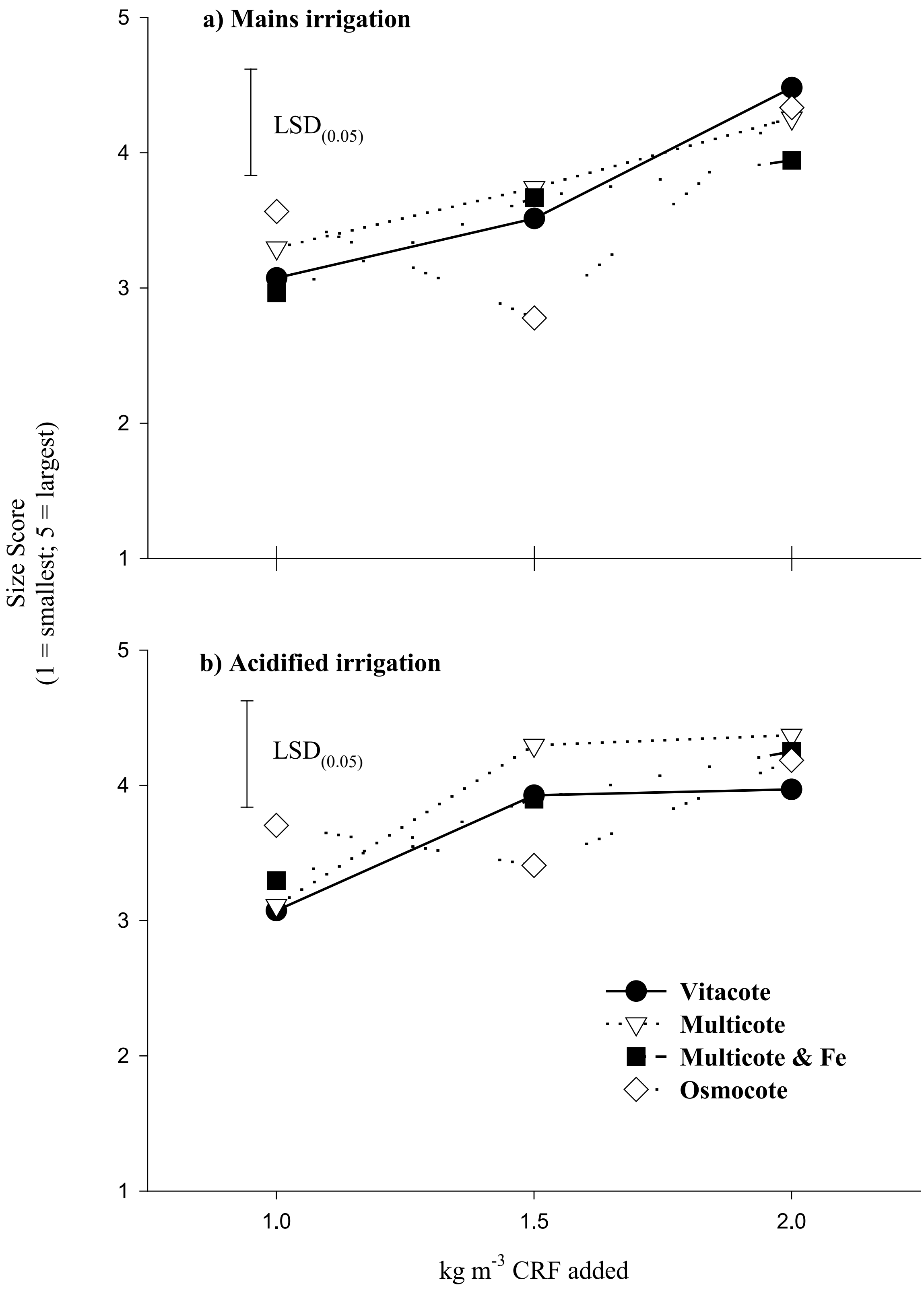

Table 7. Calluna vulgaris* 'Peter Sparkes', *HRI-Efford 1998-99
Flower score and above ground dry weight at end of trial.
(As irrigation water pH had no effect data is pooled from both treatments.)

	Flower score Autumn 2000 (1 = least; 5 = most)			Plant dry weight (g) Summer 2001 (g/3 plants)		
Fertiliser/Rate	**1.0**	**1.5**	**2.0**	**1.0**	**1.5**	**2.0**
Vitacote	2.15	3.14	2.70	2.57	3.78	4.71
Multicote8	1.86	2.02	2.26	2.84	3.93	5.13
Multicote8 & Fe	1.80	3.26	2.37	2.46	3.99	5.26
Osmocote	3.72	2.98	3.04	4.06	2.50	4.64
Grand mean		2.61			3.82	
d.f.		46			44	
l.s.d.		0.578			1.107	

***Erica vagans* 'Mrs D F Maxwell'**

Autumn 2000

No main effect was observed for irrigation pH. With mains water, plants of similar size were produced at 1.0 and 1.5 kg m^{-3} (Fig 7a). At 2.0 kg m^{-3} Vitacote produced significantly larger plants than the other CRFs. With acidified irrigation, Multicote 8 & Fe produced significantly smaller plants at 1.0 and 2.0 kg m^{-3} (Fig 7b). However, all CRFs produced similar sized plants at 1.5 kg m^{-3}.

Vitacote produced significantly more flowers than the other CRFs at 1.5 and 2.0 kg m^{-3}. Multicote 8 also produced significantly more flowers at 2.0 kg m^{-3} (Table 8).

Summer 2001

No significant differences were present between CRFs at each rate regardless of pH of irrigation water (Fig 8a & b). Overall size increased significantly with rate of incorporation of CRF.

The number of dead plants at the end of the trial appeared to be associated with CRF. Most plant losses occurred at the highest rate, with Osmocote (9), Vitacote (7), Multicote 8 & Fe (5) and Multicote (0).

Dry weight increased significantly with rate of incorporation of CRF. Only one significant difference was observed with Multicote 8 producing greater dry weight than Multicote 8 & Fe at 1.5 kg m^{-3}.

Overall

- Vitacote performed well in both acidified and mains water.
- Optimum rate for size was 1.5 kg m^{-3} for all CRFs
- Flowering was significantly increased with Vitacote
- Dry weight was greatest with Multicote 8
- Optimum for dry weight was 1.5 kg m^{-3} for Multicote 8 and Osmocote 12-14; 2.0 kg m^{-3} for Multicote 8 & Fe and Vitacote

Figure 7. ***Erica vagans*'Mrs D F Maxwell'**
Autumn 2000; HRI-Efford
Size score

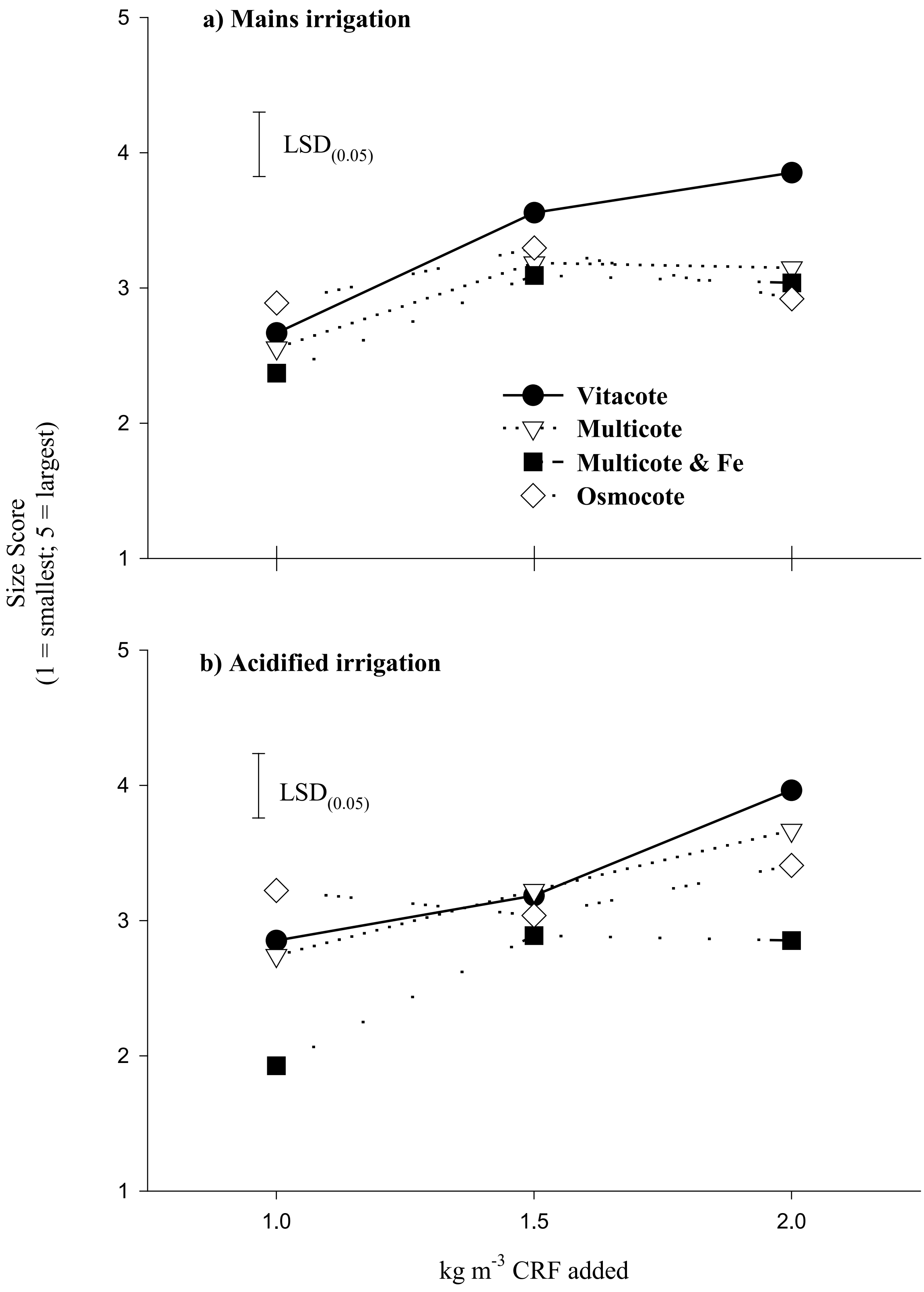

Figure 8. *Erica vagans* 'Mrs D F Maxwell'
Summer 2001; HRI-Efford
Size score

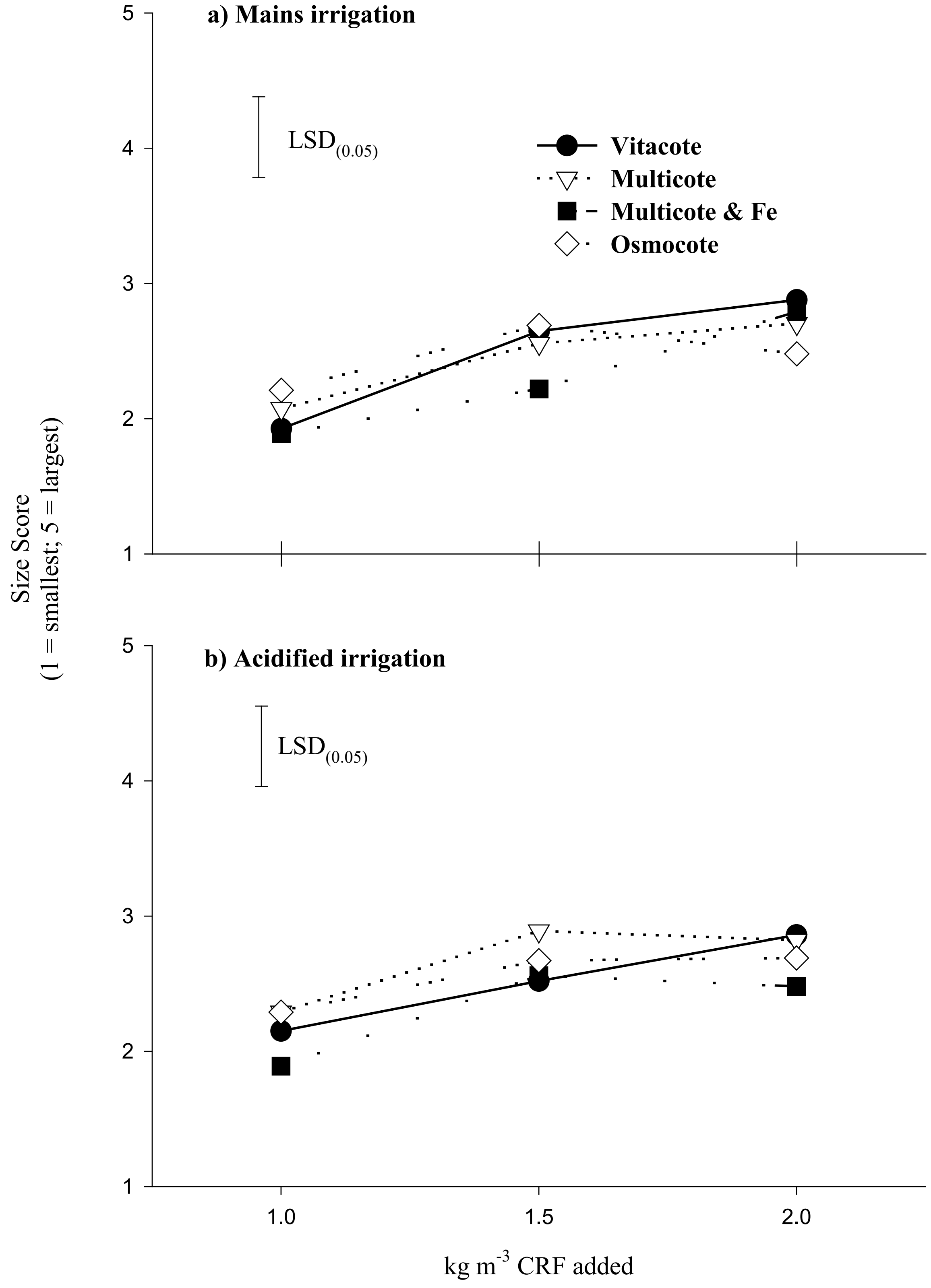

Table 8. Erica vagans* 'Mrs D F Maxwell', *HRI-Efford 1998-99
Flower score and above ground dry weight at end of trial.
(As irrigation water pH had no effect data is pooled from both treatments.)

	Flower score Autumn 2000 (1 = least; 5 = most)			Plant dry weight (g) Summer 2001 (g/3 plants)		
Fertiliser/Rate	**1.0**	**1.5**	**2.0**	**1.0**	**1.5**	**2.0**
Vitacote	2.30	4.11	4.33	3.20	4.55	5.75
Multicote8	1.82	2.96	3.52	3.72	5.58	6.09
Multicote8 & Fe	1.37	2.54	1.93	3.50	4.12	5.90
Osmocote	1.85	2.06	2.06	3.48	5.03	5.13
Grand mean		2.57			4.67	
d.f.		46			46	
l.s.d.		0.545			0.969	

Discussion

These results are from year one of a two-year study. Any findings are for the conditions *under which the experiment was carried out*. To a certain extent, extrapolation to other years is possible, but must be made with a full understanding of the limitations of this work. Additionally, account must be made of irrigation system, incorporation of soluble base fertiliser and geographical location if they differ from those in this study.

The products studied were all controlled release fertilisers. The 'control' of nutrient release is moderated by temperature. At a higher temperature, nutrients diffuse faster from the granule, resulting in a shorter 'life time' for the granule. The opposite is true at lower temperatures. Following prolonged rain, or heavy irrigation (especially overhead), a proportion of the nutrients, already released from the granules, can be leached from the pots. Consequently, nutrient availability to the plant is affected by the interaction of two factors: temperature and moisture (irrigation / rain). When the conditions are warm with heavy rainfall/irrigation the life span of CRFs will be reduced compared to cold and dry conditions.

The findings of HNS 96 showed that heather crop quality was improved through the use of Vitacote, when compared to a number of 12-14 month CRFs. It was unlikely that improvements had been achieved through a 'magic ingredient' and as such could be repeated, maybe in a more cost-effective manner. The aims of this work were to identify whether plant quality was best improved through increased iron availability, reduced CRF longevity, or higher N supply compared to a standard 12-14 month CRF.

The growing year 2000-01 was unusually wet and warm in December and February. It is likely that higher than normal amounts of nutrients will have leached from the granules, especially during February. This must be borne in mind when viewing the findings presented here. The heavy rainfall may also explain why little consistent difference was observed among CRFs with mains water and acidified water irrigation.

Relative performance of Vitacote

Over the whole growing season, Vitacote was not consistently better than any of the other CRFs studied. Although, Vitacote produced larger plants of 'Mrs D F Maxwell' and significantly more flowering in 'Mrs D F Maxwell' and 'King George'. However, at the first record in Autumn 2000 Vitacote produced plants significantly larger than one or more treatments with all cultivars. Interestingly, the rate at which this benefit was observed differed for the mains watered and acid watered plants. Plants irrigated with mains water (~ pH 8.0) responded best to Vitacote at 1.5 kg m^{-3} for all cultivars. In fact, the two *Erica carnea* ('King George' and 'Myretoun Ruby') responded well at all three rates; 'Peter Sparkes' also did well at the lower 1.0 kg m^{-3} rate and 'Mrs D F Maxwell' at the higher 2.0 kg m^{-3} rate. In contrast, plants receiving acidified water only showed the benefit of Vitacote at the highest rate (2.0 kg m^{-3}) although ‘Myretoun Ruby’ and ‘Peter Sparkes’ also responded well at 1.0 and 1.5 kg m^{-3}, respectively. The conclusions to be drawn from these responses are two-fold:

1) Plants responded to CRF treatment prior to the heavy winter rainfall, suggesting that the lack of clear data by the end of the trial *was* due to leaching of nutrients from the growing medium.

2) Acidification of the growing medium removed the benefit of Vitacote at lower rates of CRF, i.e. other CRFs performed as well as Vitacote when the iron available to the plants increased with acidification of the growing medium.

The proportion of plant deaths at the highest rate (2.0 kg m^{-3}) was lower than HNS 96, which may be due to increased leaching of nutrients as highlighted above, and where significant deaths occurred Vitacote was associated with a similar number of dead plants to Osmocote Plus 12-14 (Autumn). This was in contrast to HNS 96 where Vitacote was noted for the reduced plant losses compared to Osmocote plus12-14 (autumn).

The CRF treatments that responded similarly to Vitacote were qualitatively assessed for each variable. The data are presented in Tables 9 and 10. This approach showed that assessed variables in plants grown with Osmocote over 1.0 – 2.0 kg m^{-3} rarely matched the response of plants grown with Vitacote. Whereas Multicote 8, and to a lesser extent Multicote 8 & Fe, produced plants that responded more similarly to plants grown with Vitacote. Hence, Vitacote was producing the same plant responses as a Multicote 8 granule and that the reduced longevity of the granule may explain the different responses previously observed. This could also contribute towards the lack of significant difference in the trial. Vitacote and the two Multicote 8 CRF treatments are essentially the same treatment. This trend was not the same for *Calluna vulgaris* ‘Peter Sparkes’ where the Fe appeared clearly to be the important factor in Vitacote’s responses.

Optimum rates

As the CRF treatments were included at a range of rates it was possible to estimate the optimum rate of CRF application for the range of Heathers studied. The optimum was the rate at which growth did not significantly increase with additional fertiliser. The data are presented in Table 11, and show that a rate of 1.5 kg m^{-3} should be sufficient for most Heathers. Interestingly, the size score and dry weight of ‘King George’ benefited from additional rates of Vitacote; an unexpected finding as Erica carnea ‘King George’ is a salt sensitive cultivar.

In conclusion, no clear trend was observed for CRF response by the end of the growing season, although differences were present at the first, autumn 2000 record. It is highly likely that the exceptionally wet weather affected the trial. By protecting the plants from rainfall overwinter, the second (current) year may allow the initial questions raised in HNS 96 to be answered more conclusively.

Table 9. Qualitative assessment of which CRF(s) responded similarly to Vitacote over the whole experiment for the four species/cultivars studied (V = Vitacote; M = Multicote 8; M & Fe = Multicote 8 & Fe; O = Osmocote Plus 12-14 (Autumn))

		Erica carnea 'King George'			*Erica carnea* 'Myretoun Ruby'			*Calluna vulgaris* 'Peter Sparkes'			*Erica vagans* 'Mrs D F Maxwell'		
	CRF	**M**	**M & Fe**	**O**	**M**	**M & Fe**	**O**	**M**	**M & Fe**	**O**	**M**	**M & Fe**	**O**
2000	Mains	□	□		□				□		□	□	□
	Acidified	□					□		□		□		
2001	Mains	□				□		□	□		□		
	Acidified			□			□	□	□		□	□	□
Flowering					□				□		□		
Dry weight		□			□	□	□	□	□			□	

Table 10. Summary of qualitative assessment in Table 9.

	Overall (max = 24)
Multicote 8 core	19
Multicote 8 & Fe	12
Osmocote 12-14	6

Table 11. Showing optimum rate (kg m^{-3}) of CRF for both size and dry weight

	Multicote 8		Osmocote 12-14		Vitacote	
	Size	*Dry wt*	*Size*	*Dry wt*	*Size*	*Dry wt*
Erica carnea 'King George'	2.0	1.5	1.5	1.5	2.0	2.0
Erica carnea 'Myretoun Ruby'	1.5	2.0	1.5	1.5	1.5	1.5
Calluna vulgaris 'Peter Sparkes'	1.5	1.5	2.0	2.0	1.5	1.5
Erica vagans 'Mrs D F Maxwell'	1.5	1.5	1.5	1.5	1.5	2.0

References

Aenderkerk T G L (1996) Bemestingswijzer Boomkwekerij-gewassen. Boskoop, Boomteelpraktijkonderzoek.

Anon (1980) Trace element functions: Iron. **In** *Chelated trace elements*. Pp22-25. Interlates Ltd. England

Bould C (1955) Chelated iron compounds for the correction of lime induced clorosis in fruit. *Nature*. **175**:90-91

Gris E. (1844) Referenced in Price C A. (1968) Iron compounds and plant nutrition *Annual Review of Plant Physiology* **19**: 239-248

Scott, M (1981) The role of phosphate in the production of quality container grown nursery stock. MAFF Leaflet No. 2.

Scott M A and King C, (1987) Hardy ornamental nursery stock: acidification of irrigation water. ADAS leaflet P3064.

Tobbutt K R & Flowers T J (1997) Countering the aversion of hardy ornamentals to chalk soils Final report on MAFF project OCS 945C 19 pp