FINAL REPORT

Investigation of the benefits of incorporating base fertiliser with CRF in growing media of HNS.

HNS 43e
1998-99

Project title:	**Investigation of the benefits of incorporating base fertiliser with CRF in growing media of HNS.**
Project number:	**HNS 43e**
Project leader:	**Dr Jim Monaghan** **HRI-Efford** **Lymington** **Hants. SO41 0LZ**
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Key workers:	**Jim Monaghan - Project leader** **Carrie Hawes – Scientific support** **Shirley Foster – Scientific support**
Location:	**HRI-Efford and Johnson's of Whixley, York.**
Project co-ordinators:	**Mr John Woodhead** **Hillier Nurseries Ltd** **Ampfield House** **Ampfield** **Romsey,** **Hants. SO51 9PA** **Mr John Richardson** **Johnson's of Whixley Ltd** **New Road** **Whixley** **York** **YO5 8AQ**
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Background and Objectives

The early nutrient release from controlled release fertilisers (CRFs) can be slow and may be inadequate for early plant growth, especially if the period following potting is cold. A soluble base fertiliser would supply nutrients to the newly potted-on plant in the period before the nutrients from the CRF were released in adequate amounts. Many commercial companies suggest that the rate of CRF applied should be reduced if a soluble base fertiliser is incorporated into the growing medium at potting. This was borne out in previous work (HNS 43a) carried out at a Northern and Southern site, which demonstrated that, in some cases, plant growth and quality were maintained at a reduced rate of CRF, with the addition of soluble base fertiliser. However, this work was unable to identify the extent to which CRF rates could be reduced with the addition of soluble base fertiliser. Any reduction in CRF usage could lead to a reduction in fertiliser costs.

The objectives of this project were to:

- establish whether a proportion of the CRF can be replaced with soluble base fertiliser, with no associated loss in plant quality.

- Investigate North/South variation in response to CRF x base fertiliser for an outdoor spring potted crop

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 limitations of this work. As the growing year 1998-99 was not unusually hot and wet, lower rates of CRF would have been able to sustain quality plant growth than would be necessary in a year that was unusually hot and wet. This must be borne in mind when viewing the findings presented here.

1. *Viburnum tinus* 'Eve Price' plant size increased with rate of CRF when measured in autumn (both sites) and spring (Efford only). The addition of 0.5 kg/m^3 of base fertiliser to 4.0 kg/m^3 of CRF gave plants of equal size to 6.0 kg/m^3 CRF alone. However, the addition of base fertiliser at higher rates of CRF gave a confused picture, as no clear benefit of any rate of base fertiliser was observed at 5 kg/m^3 CRF. This overall response is difficult to explain and further work is needed to establish whether these results are a true effect.

2. With the more vigorous *Weigela florida* 'Variegata' there was a clearer response to fertiliser rates. By autumn, plant size increased with the addition of base fertiliser, at all three rates of CRF, and more growth was seen with 1.0 kg/m^3 compared to 0.5 kg/m^3 . This response was observed at both sites. Following trimming, in February, no pattern was seen in the growth

of the plants in spring. This suggested that any benefits of base fertiliser are greatest in the 'framework building' stage of growth.

3. Heavy rain in the first 4 weeks after potting, especially at Johnson's of Whixley, may have limited the amount of soluble base fertiliser available for supporting growth.

4. In general, plants in the north of England produced less biomass than in the south, due to the interaction of a number of factors: potting date, temperature and the availability of nutrients from the CRFs and base fertiliser.

Action Points

- There were strong indications with the *Weigela* that additional base fertiliser added at potting may allow a reduced rate of CRF to be used with no loss in plant quality by autumn. However, the benefits may not be obvious by the following spring.

- With *Viburnum* the addition of base fertiliser may either increase or decrease growth, with no real pattern. However, a rate of 4.0 kg/m3 CRF and 0.5 kg/m^3 base fertiliser can produce plants as large as 6.0 kg/m^3 CRF alone. Further work is needed to study this response further before firm recommendations can be made.

- No marked difference was observed in the *pattern* of responses between the northern and southern site but additional fertiliser did not overcome the effects of late potting in the north.

Practical and Financial Benefits

Further work is needed to establish the potential benefits of adding base fertiliser at a reduced rate of CRF before cost benefits can be quantified.

Science Section

Introduction

The early nutrient release from CRFs can be slow and may be inadequate for early plant growth, especially if the period following potting is cold. A soluble base fertiliser would supply nutrients to the newly potted-on plant in the period before the nutrients from the CRF were being released in adequate amounts. Previous work (HNS 43a), carried out at a Northern and Southern site, demonstrated that, in some cases, plant growth and quality were maintained at a reduced rate of CRF, with the addition of soluble base fertiliser. However, this work was unable to identify the extent to which CRF rates could be reduced in conjunction with the addition of soluble base fertiliser.

The basal premise is that in a cool spring, when light levels and temperature are sufficient to support active growth, but the temperatures are still at a level where nutrient release from CRF is slow (or alternatively the CRF coating hasn't yet responded to the higher temperatures) plant nutrient requirements will exceed nutrient availability. This can be overcome by a) incorporating CRF at a higher rate, so the low rate of release from increased numbers of granules will be adequate or b) adding supplementary available nutrients in the form of soluble base fertiliser.

The objectives of this project were to :

- Study the effect of incorporating base fertiliser into the growing media and the interaction of rate of base fertiliser with rate of CRF.

- Investigate North/South variation in response to CRF x base fertiliser for an outdoor spring potted crop

Materials and Methods

HRI-Efford & Johnson's of Whixley

Treatments

Table 1. Rate of CRF and base fertiliser incorporated in each treatment.

Treatment	Rate incorporated (kg/m^3) Osmocote Plus 12-14 Spring (15+9+11+2+traces)	PG mix (12+14+24)
1	4.0	0.0
2	5.0	0.0
3	6.0	0.0
4	4.0	0.5
5	5.0	0.5
6	6.0	0.5
7	4.0	1.0
8	5.0	1.0
9	6.0	1.0

Growing System

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

Growing medium 100% Irish premium peat
1.5 kg/m^3 Mg Lime
750 g/m^3 suSCon green

Start material 9 cm liners bought in and potted-on into 3 litre containers

Species *Viburnum tinus* 'Eve Price'
Weigela florida 'Variegata'

Potting date HRI-Efford week 21 (18/05/98)
Johnson's of Whixley week 22 (25/05/98)

Design

Randomised block design with three plots per treatment and 10 plants per plot. Six plants were recorded with 4 plants acting as guard plants.

Efford:
2 species x 9 treatments x 3 reps = 54 plots

Johnson's of Whixley:
2 species x 9 treatments x 3 reps = 54 plots

Assessments

Plants were assessed in October 1998 and after the first flush of growth, in May 1999. The variables recorded differed with species, as appropriate, and are outlined in the results section.

Measurements of height and width were taken directly. Scoring of colour, vigour and form was subjective; made by visual comparison against selected standards each time. Both Efford and Johnson's of Whixley were recorded against the same score plants, which were transported to the Northern site and were scored and sampled in the same manner as HRI-Efford, and at similar stages of growth. 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 the standards. 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 conditions as all the recorded plants. The standards were measured and photographed before being replaced. The standards were selected anew each time plants were scored.

Above ground biomass was recorded for half of all recorded plants by destructive sampling after the spring flush of growth.

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 at the beginning of Summer and during October (see Table 2). Rainfall was frequent but periods of low rainfall (<10mm / week) were observed in August and September.

The highest temperatures were recorded week 32 and 33 in 1998 and week 22 in 1999. Over winter there were two cold periods in week 49 and 7. An unusually cold week in April (wk 14) affected new growth on some of the outdoor plants at Efford (Figure 1).

Table 2. Monthly average rainfall, maximum and minimum temperatures at HRI-Efford as a percentage of the 49 year monthly average.

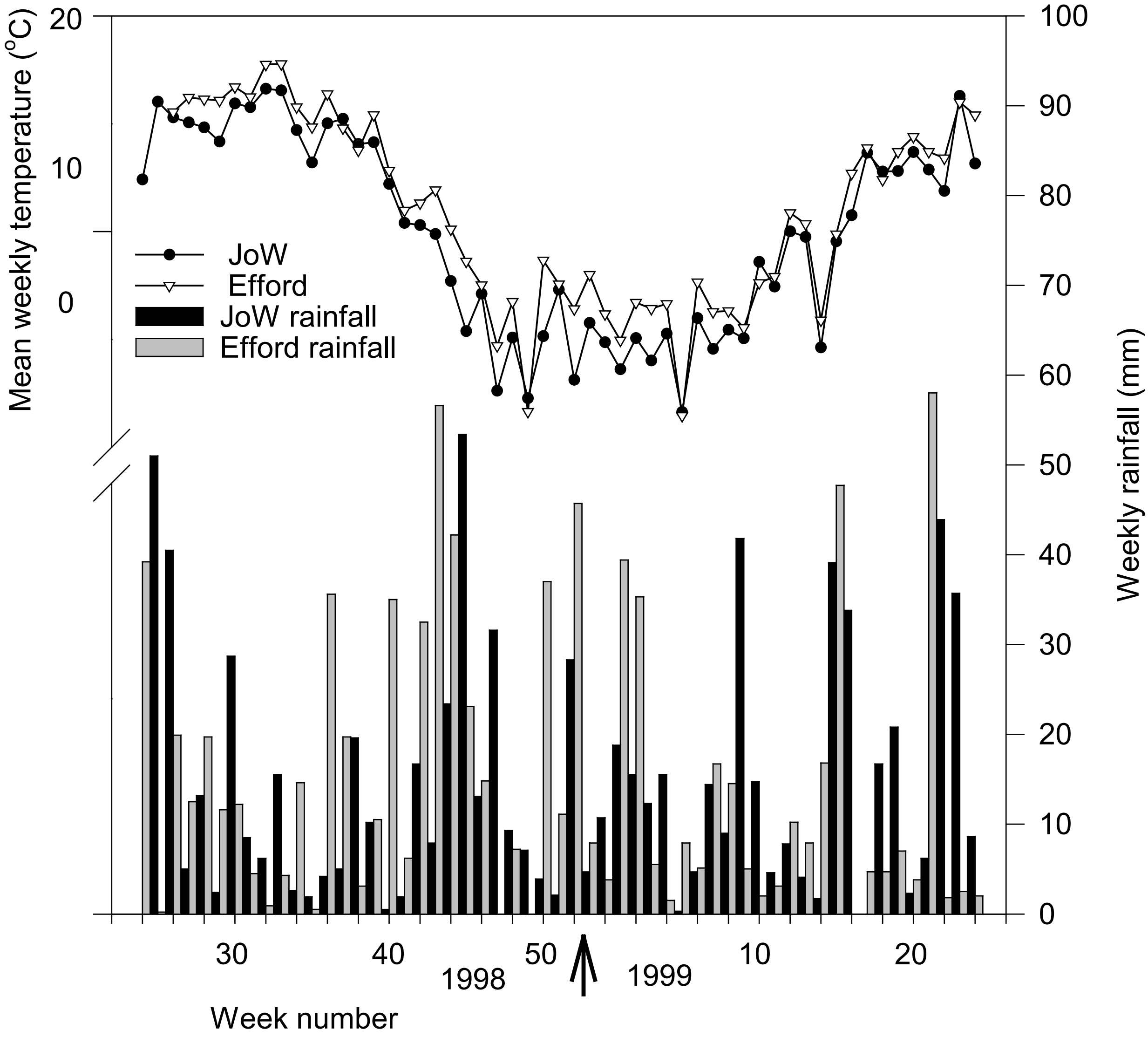
1998	May	June	July	Aug	Sept	Oct	Nov	Dec
first full week no.	*19*	*23*	*28*	*32*	*36*	*41*	*45*	*49*
Rainfall (mm)	44	158	105	36	30	171	52	108
Max °C	119	95	93	101	103	-	100	109
Min °C	128	114	101	91	109	100	92	115

1999	Jan	Feb	March	April	May
first full week no.	*1*	*5*	*9*	*14*	*18*
Rainfall (mm)	128	63	55	166	43
Max °C	-	-	88	110	112
Min °C	178	155	100	136	130

Johnson's of Whixley

Compared to Efford, temperatures at Johnson's of Whixley were generally lower. Over the duration of the experiment, the average daily temperature was 1.2 °C lower than Efford; and the average daily temperature was higher in only five of the 45 weeks that the experiment was concurrent on the two sites (Figure 1). Although the rainfall pattern differed, over the growing season only 5 mm more rain fell at Johnson's of Whixley than at Efford.

Figure 1.Temperature and rainfall at
HRI-Efford and Johnson's of Whixley Spring 98 to Spring 99



***Viburnum tinus* 'Eve Price'**

Size – Autumn 1998

By autumn, the plants grown at the northern site were significantly smaller than those grown at Efford. The differences between fertiliser treatments were also smaller and no significance differences were observed in size between any treatments at Johnson's of Whixley.

At Efford, plant size increased with CRF rate in the treatments that included no base fertiliser (Figure 2). This trend was also repeated at Johnson's of Whixley. The addition of 0.5 kg/m^3 of base fertiliser led to increase in size at 4 kg CRF but had no effect at 5kg/m^3 and appeared to limit growth with 6 kg/m^3 CRF. The addition of 1.0 kg/m^3 of base fertiliser again improved growth at the lowest CRF rate compared to CRF alone (although by a smaller amount) but had little effect at 5kg/m^3 and again appeared to limit growth at the highest rate of CRF.

Flowering – Autumn 1998

Flowering was minimal at Johnson's of Whixley and was not scored. At Efford flowering was scored but did not differ significantly between treatments (Table 3). Although, overall there appeared to be more flowers produced by the plants grown at the lowest rate of CRF.

Table 3. Flowering score of Viburnum tinus* 'Eve Price' *at HRI-Efford autumn 1998

	Base fertiliser (kg/m^3)		
CRF (kg/m^3)	**0**	**0.5**	**1.0**
4.0	3.7	3.0	1.0
5.0	1.7	3.7	3.7
6.0	3.0	1.7	1.0

Size – Spring 1999

Following winter and the spring flush of growth, plant size was scored at both sites. As for the autumn records the plants at Johnson's of Whixley were smaller than those at the southern site, and differences between treatments were not significant. The plants at Efford showed a pattern of response to treatments similar to the autumn record. The one exception was the plants grown with 6 kg/m^3 of CRF and 0.5 kg/m^3 of base fertiliser, which on average were relatively larger, compared to the autumn score (Figure 3).

Dry weight – Spring 1999

Overall, the plants at Efford produced about twice as much biomass by the end of the experiment as those grown at Johnson's of Whixley (Table 4). As with the size scores, no significant differences were observed between treatments for the dry weight of the plants grown at Johnson's of Whixley. At Efford the biomass also followed a similar pattern to the spring size score with the lowest biomass produced by the plants grown with 4.0 kg/m^3 of CRF, and the largest biomass at the same rate of CRF with 0.5 kg/m^3 base fertiliser.

Table 4. Biomass of above ground plant parts of Viburnum tinus* 'Eve Price' *HRI-Efford and Johnson's of Whixley, Spring 1999.

CRF	Base fertiliser	Biomass of above ground plant parts: HRI-Efford	Biomass of above ground plant parts: Johnson's of Whixley
(kg/m^3)		(g / 3 plants)	
4.0	-	71.9	37.9
	0.5	114.2	48.2
	1.0	93.1	51.8
5.0	-	94.8	40.1
	0.5	78.8	39.2
	1.0	103.0	44.2
6.0	-	96.5	42.2
	0.5	95.4	41.6
	1.0	76.5	42.2
	df	16	16
	SED	15.29	8.40
	$LSD_{(0.05)}$	30.70	16.88

Figure 2. ***Viburnum tinus*** 'Eve Price' Size score autumn 1998, HRI-Efford and Johnson's of Whixley.

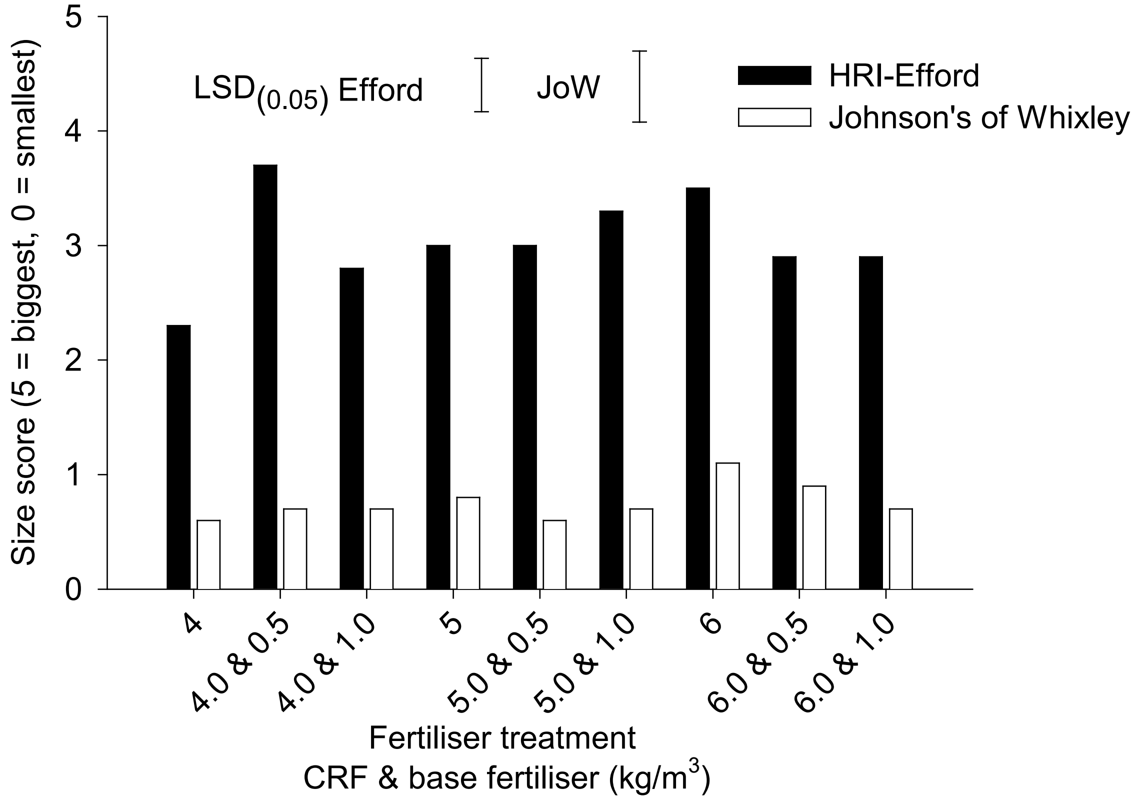
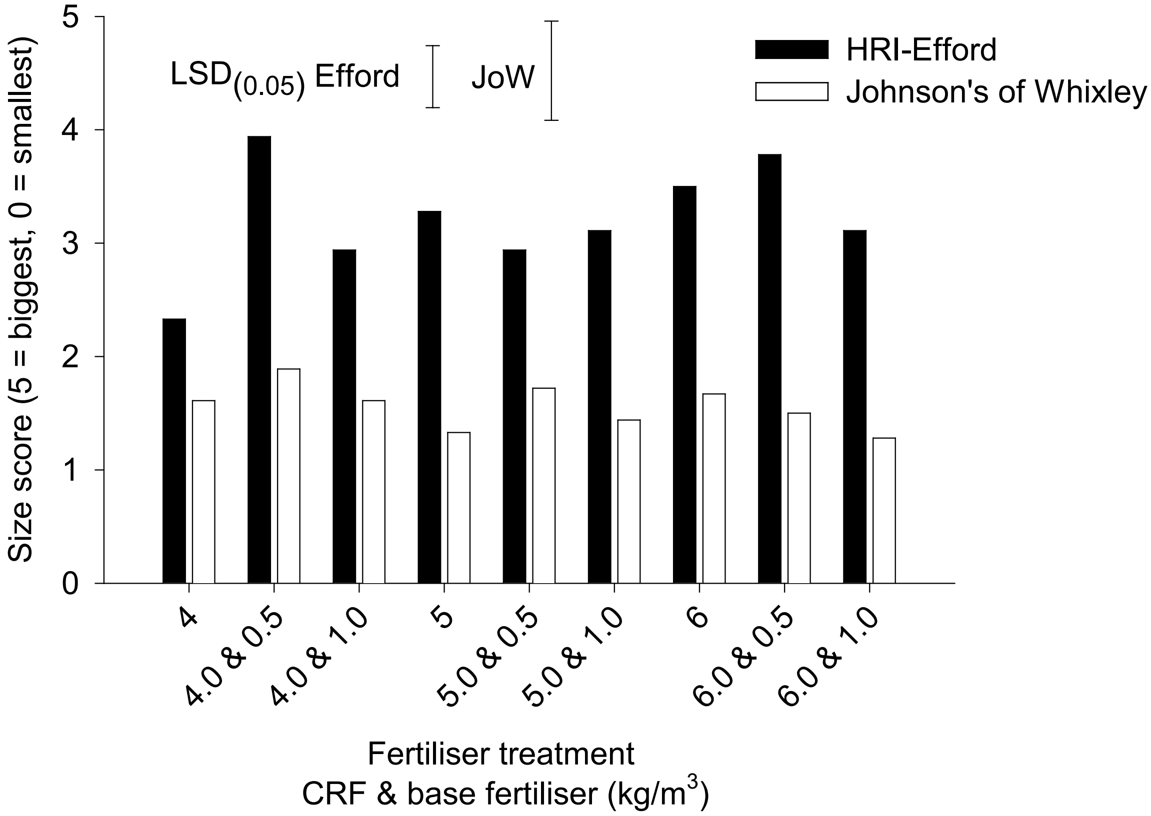


Figure 3. ***Viburnum tinus*** 'Eve Price' Size score spring1999, HRI-Efford and Johnson's of Whixley.



***Weigela florida* ‘Variegata’**

Plants were scored for size autumn 98, and for size and flowering spring 99. Trimmings were weighed from pruning in February 99.

Size – Autumn 1998

By autumn, the plants grown at Johnson’s of Whixley were significantly smaller than those grown at Efford. However, a clear trend was observed where rate of CRF and base fertiliser appeared to be additive with the smallest plants being grown with 4.0 kg/m^3 CRF and the largest with 6.0 kg/m^3 CRF and 1.0 kg/m^3 base fertiliser (Figure 4). This trend was present to a lesser extent at Efford. At Johnson’s of Whixley there was a significant main effect for both CRF and base fertiliser rate, with growth increasing with both; at Efford only the rate of base fertiliser exhibited a significant main effect on increasing plant growth.

Trimming dry weight - Winter 1999

The plants were trimmed in February 1999 and demonstrated a similar pattern to the Autumn size scores (Figure 5). The plants grown at Johnson’s of Whixley produced 60% trimming dry weight of those grown at Efford.

Size – Spring 1999

Following pruning the new flush of growth was scored. The scores for both sites were much closer than in autumn 1998, and although overall the plants at Efford were larger, there were no significant differences between treatments. At Johnson’s of Whixley plants grown with 5 kg/m^3 of CRF only were significantly smaller than those grown with 4 kg/m^3 of CRF or 4 kg/m^3 CRF with 0.5 kg/m^3 base fertiliser. Interestingly, at both sites there was an indication that a lower rate of CRF was producing more growth when no base fertiliser was incorporated (Figure 6).

Flowering – Spring 1999

The plants at Johnson’s of Whixley were hit badly by frost when a large number of plants died, rendering the data unusable. Consequently, the spring assessments were undertaken at Efford only. No significant differences were measured in the flowering of *Weigela* (Table 5) although there was some indication that when no base fertiliser was added flowering decreased with rate of CRF.

Table 5. Flowering score of Weigela florida* 'Variegata' *at HRI-Efford spring 1999

CRF (kg/m^3)	Base fertiliser (kg/m^3) 0	0.5	1.0
4.0	3.3	3.3	2.9
5.0	2.7	3.5	3.1
6.0	2.5	3.0	3.5

Dry Weight – Spring 1999

Dry weights were only calculated for the plants at Efford. No significant differences were observed in the data and no trends were apparent (Figure 7).

Figure 4. ***Weigela florida*** 'Variegata' Size score autumn 1998, HRI-Efford and Johnson's of Whixley.

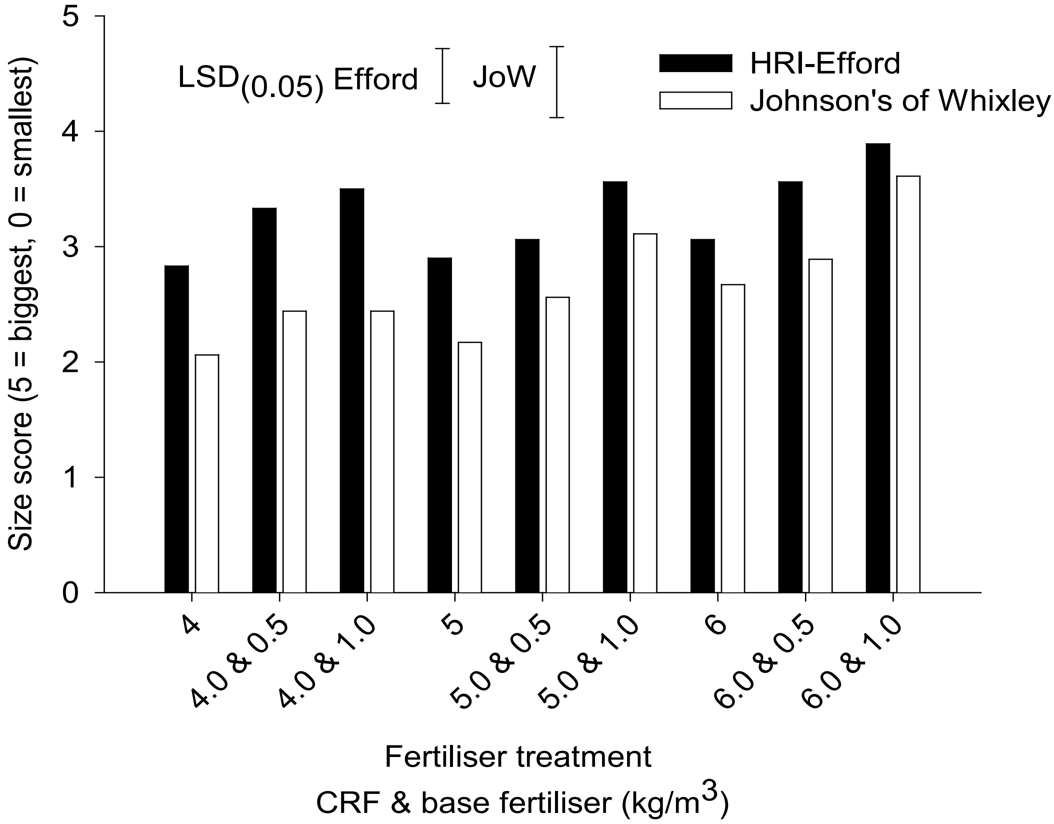


Figure 5. ***Weigela florida*** 'Variegata' Trim weights Winter 1999, HRI-Efford and Johnson's of Whixley.

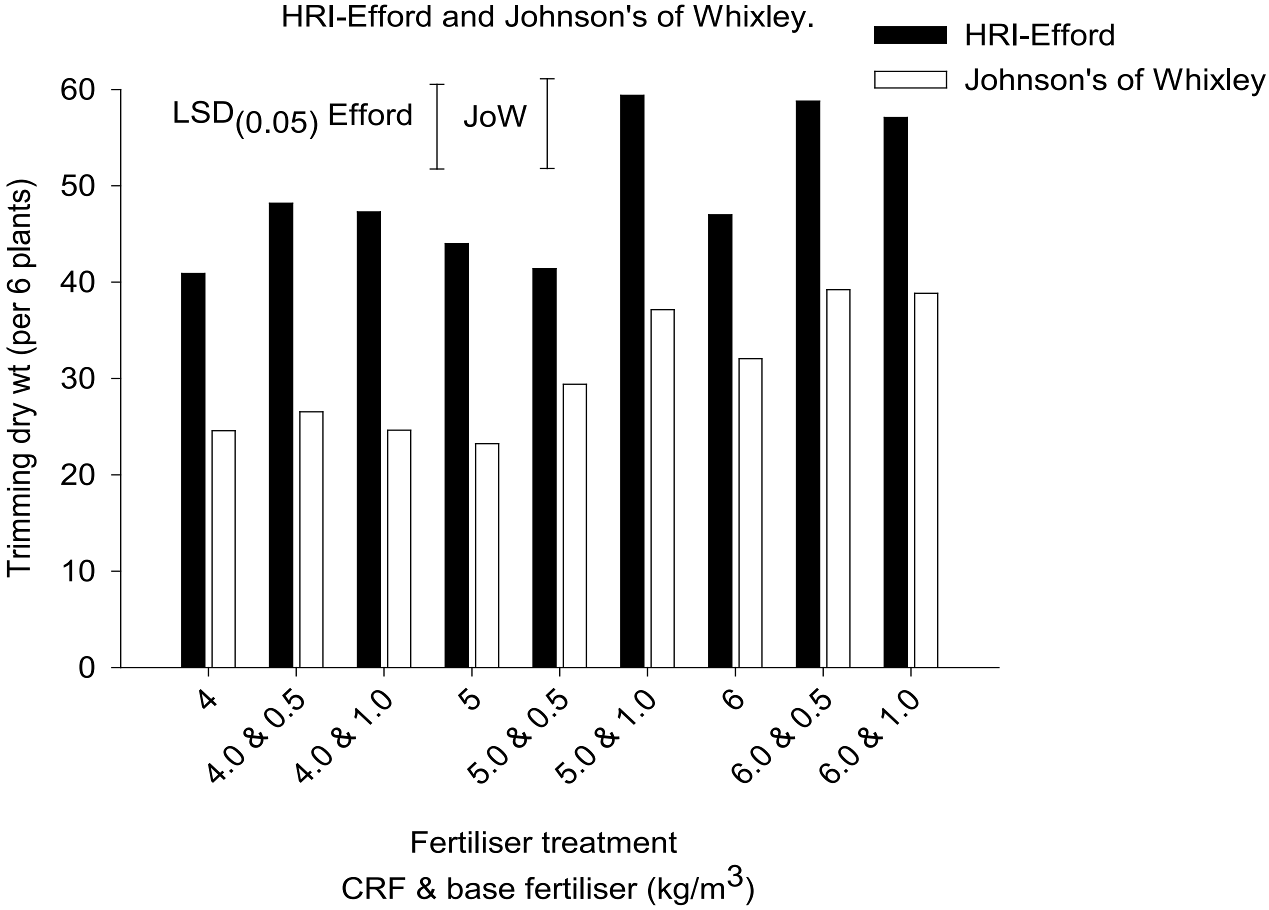


Figure 6. ***Weigela florida*** 'Variegata' Size score spring 1999, HRI-Efford and Johnson's of Whixley.

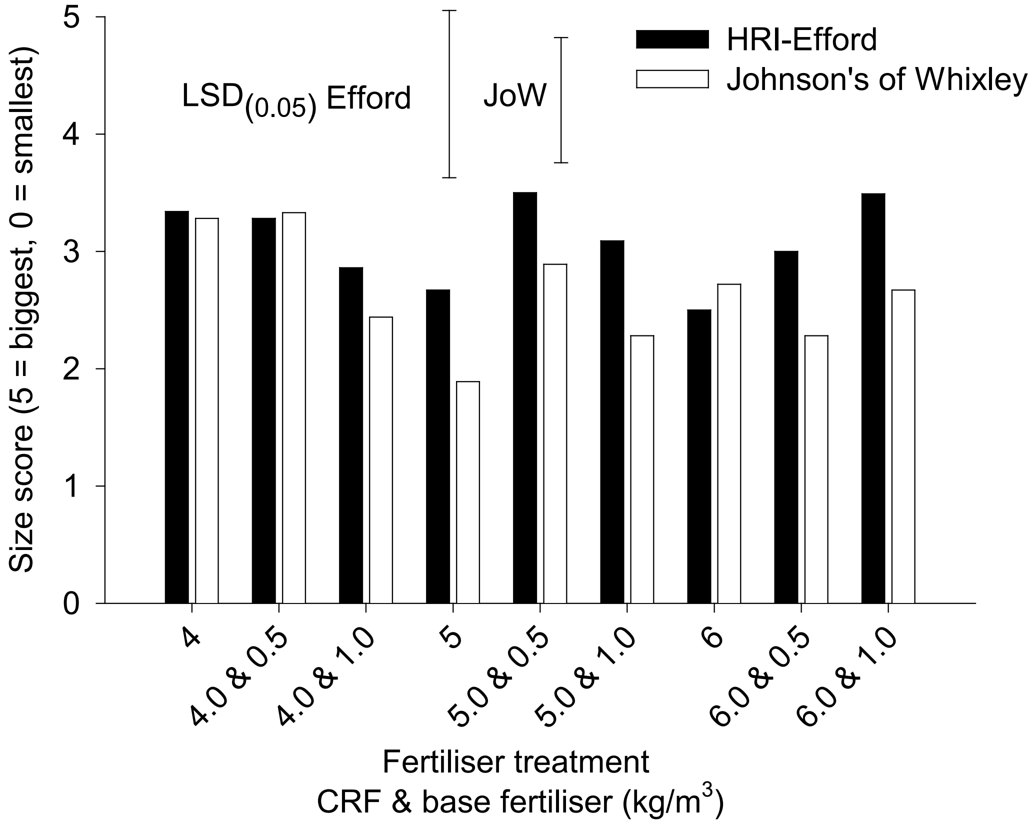
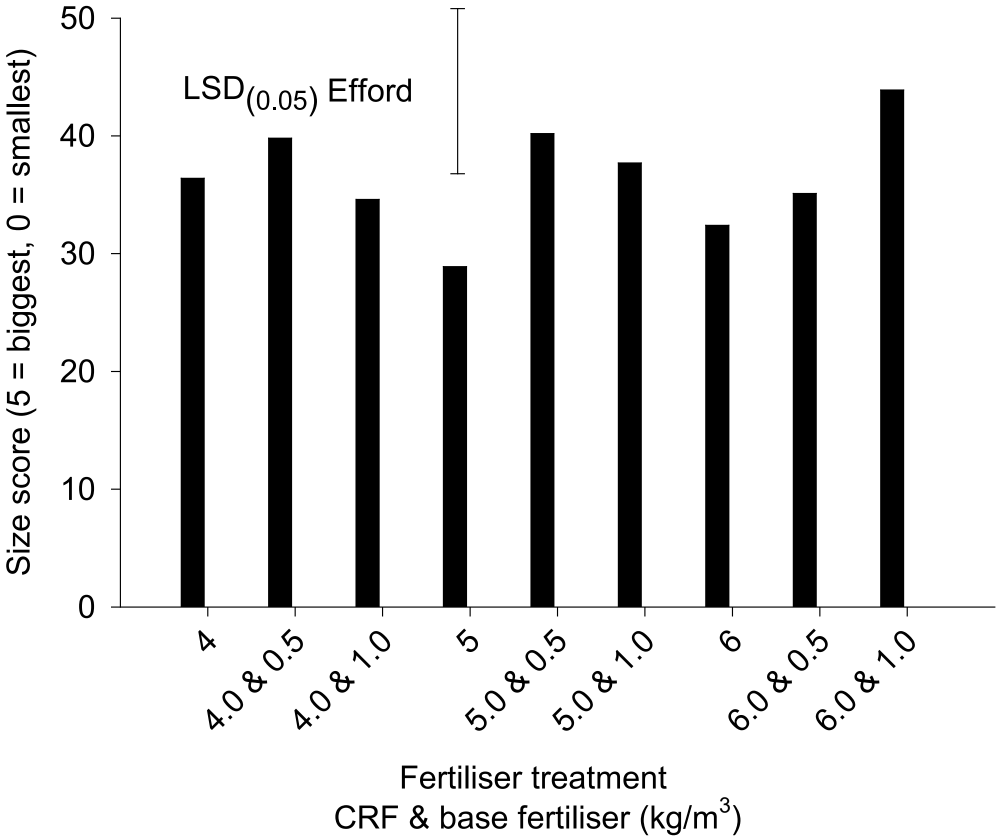


Figure 7. ***Weigela florida*** 'Variegata' Final dry weight HRI-Efford, spring 1999



Discussion

This study examined the interaction between the addition of soluble base fertiliser with the rate of controlled release fertiliser (CRF), with an aim to providing guidance as to the extent that CRF rates could be reduced with the addition of cheaper soluble base fertiliser at potting, and additionally, whether geographical location affected the response. 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 limitations of this work.

Viburnum tinus 'Eve Price'

When plant responses to the rate of CRF without any additional base fertiliser were examined *Viburnum* plant size increased with rate of CRF in autumn at both sites and spring at Efford alone. However the addition of base fertiliser to these CRF rates gave a confused picture. The addition of 0.5 kg/m^3 of base fertiliser to 4.0 kg/m^3 of CRF gave plants of equal size to 6.0 kg/m^3 CRF, but the addition of 1 kg/m^3 significantly reduced growth compared to 0.5 kg/m^3 base fertiliser. A similar response was seen at the highest rate of CRF. Surprisingly, no clear benefit of any rate of base fertiliser was observed at 5 kg/m^3 CRF. This overall response is hard to explain and further work is needed to establish whether these results are a true effect.

Weigela florida 'Variegata'

Weigela is a more vigorous species than *Viburnum,* and the vigorous early growth of *Weigela* benefited from the addition of soluble base fertiliser. At all three rates of CRF, and at both sites, plant size increased with the addition of base fertiliser, and more growth was seen with 1.0 kg/m^3 compared to 0.5 kg/m^3. Decreasing the rate of CRF (without the addition of base fertiliser) from 6.0 to 4.0 kg/m^3 had little effect on plant size, underlining the crucial effect of early nutrient supply on final plant size of *Weigela*.

The greatest increase in plant growth was observed when base fertiliser was added to the higher rates of CRF. This underlines the need for adequate nutrition to support continued growth after the base fertiliser is exhausted. Following trimming, no pattern was seen in the new growth of the plants, emphasising that base fertiliser predominantly effects early growth.

Effect of geographical location

The general response, with plants in the North producing less biomass than in the South, can be accounted for by the interaction of a number of factors: potting date, temperature and the availability of nutrients from the CRFs and base fertiliser. Plants were potted up in May at both sites, which was an acceptable potting date for the South but rather late in the North due to the shorter growing season.

Over the duration of the experiment, the average daily temperature at Johnson's of Whixley was 1.2 °C lower than Efford; and was higher in only 5 out of the 45 weeks that the experiment was concurrent on the two sites. The release of nutrients from CRF was measured on an adjacent concurrent experiment undertaken at both Efford and Johnson's of Whixley (HNS 43d), and showed that the temperature difference had a marked effect on the release rate of nutrients from the CRF granules, with the amount of nutrients (N, P and K) remaining in the granules at the end of the trial significantly less at Efford than Johnson's of Whixley.

The colder initial temperatures at Johnson's of Whixley suggest that growth would benefit most from the early nutrients available from the soluble base fertiliser. However, in the first 4 weeks following potting 109.7 mm of rain fell at Johnson's of Whixley compared to 52.1 mm at Efford. Soluble base fertiliser readily goes into solution, and can be washed out of the growing medium over a short time if rainfall is heavy. Laboratory trials studying the use of zeolite as a buffer of excess nutrients (HNS 43d) showed that half of the soluble base fertiliser could be leached out of the growing medium after four irrigation events (i.e. where pots were flushed through to collect leachate). This heavy rain especially at Johnson's of Whixley's may have limited the amount of soluble base fertiliser available for supporting growth, and in a drier year the plant responses to rates of base fertiliser may have been greater than those reported here.

Conclusions

From one years experimental work.

- There were strong indications with *Weigela florida* 'Variegata' that additional base fertiliser added at potting may allow a reduced rate of CRF to be used with no loss in plant quality. However, benefits were clearest in the first season of growth prior to pruning back.

- With *Viburnum tinus* 'Eve Price' the addition of base fertiliser both increased growth and decreased growth with no real pattern. Nevertheless, plants grown with 0.5 kg/m^3 of base fertiliser and 4.0 kg/m^3 of CRF were of equal size to those grown with 6.0 kg/m^3 CRF. The results are not clear at higher rates of CRF and further work is needed before clear conclusions can be drawn.

- No marked difference was observed in the *pattern* of responses between the northern and southern site but additional fertiliser did not overcome the effects of late potting in the north

References

HNS 43a. An investigation into the use of controlled release fertilizers for spring potting of container nursery stock grown outdoors. Final report 1994-1996. (Scott MA, Davies EM, and Girard 1997)

HNS 43d. Comparison of 12-14 month CRFs under protection and outdoors at different potting dates. Final report 1998-1999 (Monaghan JM and Scott MA, 1999)