A SLOW-RELEASE FERTILIZER FOR NURSERY PLANTS IN CONTAINER

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Abstract

During three years at three locations, experiments with a shrub (Pyracantha) and a conifer (Chamaecyparis or Cupressocyparis), grown in containers, were carried out to establish whether the slow-release fertilizer Osmocote 18+6+12 with a release period of 8-9 months, mixed through the potting soil as a basal dressing at the start of the season, could replace topdressings of the water-soluble NPK-compound 18+6+18 Kristallijn, given weekly during the growing season.

Between the two methods of fertilization only small, variable differences in growth occurred so that these methods may be considered equivalent. A strongly growing plant may derive some extra benefit from a combination of a suboptimum rate of Osmocote with continuous or late topdressing of Kristallijn.

High rates of each fertilizer may be detrimental to the quality of Chamaecyparis by producing a poorly shaped plant, and diminish winterhardiness of Pyracantha.

1. Introduction

For growing nursery plants in container, a weekly topdressing with water-soluble NPK-compounds is currently recommended. During three years on three locations and with two nursery species a study was made to determine if the slow-release fertilizer Osmocote 18+6+12 as basal dressing can replace the topdressings. This would save labour and perhaps cause less pollution of the environment by diminishing the leaching of nutrients from the pots.

A protracted after-effect of the slow-release fertilizer in autumn could be the cause of insufficient winterhardiness of the plants. To test this, the plants were wintered in pot outdoors and the viability of the root system was assessed in the following spring.

2. Materials and methods

Experiments were carried out during three years, 1974-1976, with a shrub and a conifer, at three locations: the Research Station for Arboriculture at Boskoop, the Experimental Garden for Arboriculture in Horst, and the Institute for Soil Fertility at Haren.

The trials consisted of factorial combinations of Osmocote rates as the basal dressing and topdressings of the water-soluble NPK-compound Kristallijn. In spring, various amounts of Osmocote, an 8-9 months' slow-release NPK-fertilizer 18+6+12, were mixed through the potting soil. The slow-release mechanism is obtained by coating granules of high-analysis soluble fertilizer with copolymers of soybean and linseed oil. The thickness of the coating determines the rate of release. Temperature strongly affects this rate, but neither the water content of the soil, at least within the range important for plant growth, nor the pH, nor microbial activity has a distinct effect

(Lunt and Oertli, 1962; Oertli and Lunt, 1962; Penningsfeld and Fischer, 1979). At Haren, 6 Osmocote levels were applied in 1974 and 8 in the following years (see table 1). The first 6 levels were combined with seven treatments with the NPK-compound Kristallijn 18+6+18 as topdressing (table 1). The experiments at Boskoop and Horst consisted of a selection of these treatments. In 1974, the experiment in Haren was carried out with 8-10 replications per treatment (one unit = one pot) and in the following years with 3 replications (one unit = 6 pots). The trials at the two other places consisted of a two-fold replication with 50 plants per treatment in a replication in 1974; in 1975 and 1976, there were 4 replications with 25 plants for each treatment and replication.

Rooted cuttings of *Pyracantha* 'Orange Glow' were potted in spring. As second experimental cultivar, *Chamaecyparis lawsoniana* 'Columnaris' was used in 1974, *Chamaecyparis lawsoniana* 'Golden Wonder' in 1975, and *Cupressocyparis leylandii* in 1976. The plants were potted in 1-litre Testadur-plastic pots, filled with a commercial potting mixture, consisting of frozen black peat (garden peat) and 10% clay, to which had been added 1.5 kg NPK-compound 16+10+20, 0.5 kg superphosphate, 4 kg lime and 250 g trace element mixture per m^3. As soil analysis in 1974 showed that the contents of the major nutrient elements were high, too high for the moderate demand of nursery plants, the amount of the NPK-compound in the potting mixture for the experiments in 1975 and 1976 was lowered to a fourth of the amount mentioned above.

Water supply during growing was as close to optimum as possible. Because at Boskoop salt ditch water was used, ample water was given to avoid salt accumulation.

In the growing season the nutrient status of the potting soil was determined three times by soil testing. Measurements and estimates were used to establish growth differences among treatments. After the winter, new growth of the root system was evaluated as a measure of the effect of fertilization on the winterhardiness of the plant.

3. Results

3.1. Growth of the plants

3.1.1. Quantity of NPK-compound in topdressing

A weekly topdressing of 20 g/m^2 water-soluble NPK-compound Kristallijn 18+6+18 for rooted cuttings and conifers and even 30 g/m^2 for shrubs is a recommended practice (Rijswijk, 1975). In this way large amounts of fertilizer are supplied. Therefore in the experiment in Haren the possibility of using lower applications was studied anew, now with water of good quality instead of the high-chloride ditch water as used in Boskoop. In terms of plant growth as measured by stand, leaf colour, plantheight, weight, shape of the plant, etc., a significant interaction between quantity of Kristallijn and Osmocote was present in only a few instances for the conifers, but for *Pyracantha* much more frequently (table 2). This means that *Pyracantha* needs less Kristallijn as topdressing if Osmocote is mixed through the potting soil as a basal dressing. Without basal dressing, at least 20 g/m^2/week is necessary. With basal dressing, this quantity gave yet an additional positive effect. For shrubs, in general, a quantity of 20 g/m^2/week may be recommended. Roughly speaking, differences in growth among the treatments were small for the conifers, a dose of 10 g/m^2 being sufficient for the cultivars tested. Even without Osmocote, there was little or no benefit from a higher level of Kristallijn.

The results of the experiments did not indicate that a weekly topdressing during half a season should be heavier than one given during the entire season.

3.1.2. Basal dressing with Osmocote or topdressing with Kristallijn

This section deals with the question whether Osmocote alone - which would reduce labour during the summer - or topdressing with Kristallijn alone would be the better treatment. Possibly a combination would be advantageous; this will be discussed in the succeeding section.

With a quadratic regression equation, maximum growth at the optimum rate of Osmocote was calculated (table 3). Calculated maximum growth is of course somewhat theoretical and could only have been obtained if at the start of the relevant trial the optimum dose of Osmocote had been known and mixed through the potting soil. This maximum growth can be compared with the results of continued topdressing with Kristallijn. There is no decisive difference, now the basal dressing was superior, then again the other method scored higher. Only one statistical significant difference in height between the two methods occurred. When Pyracantha was topdressed during the latter half of the season, growth distinctly lagged behind. The difference in growth between early and late topdressing was less distinct for Chamaecyparis. Obviously, the basal dressing with the NPK-compound 16+10+20 was better able to sustain adequate growth of this conifer than of Pyracantha. For Cupressocyparis, which grows more rapidly than Chamaecyparis, omission of early topdressing was again less desirable.

Pyracantha required a larger amount of Osmocote than the conifers. In 1974, when the potting mixture contained the usual amount of NPK-compound, the mean optimum rate for maximum height of Pyracantha was 5.8 g Osmocote/l potting soil; in the two following years, when the amount of NPK-compound had been reduced to a fourth, it was 8.8 g/l. The respective optimum rates for the conifers were 4.2 and 5.3 g/l.

3.2. Basal dressing with Osmocote in combination with topdressing with Kristallijn

It is conceivable that a topdressing, in addition to the required amount of Osmocote as a basal dressing, would have an added beneficial effect. The time of application may also be of interest: an early topdressing in case the release of nutrients is late or slow, or a late topdressing if the slow-release fertilizer works too fast relative to the uptake rhythm of the plant.

Table 4 shows the extra growth obtained after topdressing with Kristallijn when an amount of Osmocote closest to the calculated optimum rate was given. Continuous and late topdressing gave a slight, statistically nonsignificant increase in growth in more than half of the cases. It was reported in the previous section that in the absence of Osmocote, early topdressing was best. In the presence of Osmocote, late topdressing was preferable. This indicates that the release of nutrients from Osmocote is sufficient early in the season, while it is probably too slow or has ceased at the end of the summer.

Possibly a combination of topdressing and a lower, suboptimum dose of Osmocote is superior. To study this interaction, the height of the plant was plotted against the Osmocote rates as dependent upon the method of topdressing (figures 1 and 2). To eliminate the effect of location and year on growth, relative heights were used, the second highest treatment mean in each experiment being put at 100%. For maximum growth of conifers without topdressing, 3-4 g Osmocote was found to be sufficient. Continuous and late topdressing lowered the optimum rate to 2-3 g. On the average, no greater plant height can be obtained from the combined action of basal dressing and topdressing. Early topdressing after basal dressing with Osmocote did not give any advantage. Excess of nutrients, from Osmocote alone or in combination with Kristallijn, is more detrimental to conifers than to Pyracantha. The optimum rate for Pyracantha without topdressing was 5 g Osmocote/l. When the basal dressing had been underestimated, an early topdressing worked favourably, but a late one failed. The curve for continuous topdressing was flat, which indicates that, in the case of continuous topdressing, the basal dressing had little effect. Kristallijn without basal dressing gave almost maximum growth of Pyracantha. Certain combinations of basal and topdressing seem to give extra growth of Pyracantha, but the differences are only small.

When the treatment means for plant height as well as for the other growth and quality characteristics were ranged and when the frequency with which the five best treatments per location and year occurred was evaluated, the combination of Osmocote level 3 (see table 1) with continuous or late topdressing turned out to be the best. This means for Pyracantha a dose of 5-6 g and for the conifers an amount of between 2.67 and 5 g Osmocote/l. Differences from other combinations, however, are small and it is doubtful that combined fertilization is economical, in view of the large amounts of nutrients involved.

3.3. Quality of Chamaecyparis

In 1975, high doses of fertilizer had a deleterious effect on the shape of Chamaecyparis plants. The highest part of the plant lost its pointed shape, and the top of the plant was bent over. The deformation occurred both with Osmocote and with Kristallijn. Continuous topdressing was the most unfavourable treatment, then followed early dressing. In view of possible damage, caution should be exercised in applying large amounts of fertilizer to susceptible cultivars.

3.4. Winterhardiness

It is of interest to know the effect of dressing upon winterhardiness. Therefore topdressing was continued until late in the season so as to accentuate possible injurious effects. Plants in pot were wintered without protection, which Pyracantha withstood poorly. Winterhardiness decreased with increasing rates of Osmocote (table 5). Late or continuous topdressing sometimes caused a reduction in new growth of the root system in spring. The nutrient status of the conifers had little effect upon their survival during winter.

3.5. Soil testing

Soil samples were taken in the second half of May when topdressing with Kristallijn began, in mid-August (change in topdressing), and in mid-September. They were analysed in a soil-water extract 1:1.5 (v/v)

(Sonneveld et al., 1974). In the second half of May, about six weeks after planting, Osmocote applications had clearly increased the contents of soluble N, P and K (table 6). Neglecting nutrient uptake by the plant and loss due to leaching, some 40-60% of the nitrogen had, roughly estimated, been released by the Osmocote. The soil content in August was higher still. Thus, the release of nutrients from Osmocote in the course of the season was higher than nutrient uptake by the plant, soil adsorption, and leaching from the pot. In September the reverse is true, the contents had then decreased. Topdressing with the water-soluble NPK-compound Kristallijn increased the contents, but not as much as Osmocote. A part of the Kristallijn may have fallen beside the pot, or may have leached out rapidly. Increasing rates of Osmocote distinctly lowered the pH. Also Kristallijn lowered the pH. When a slow-release fertilizer is used, extra lime should be given to compensate for acidification through nitrification of ammonium (Arnold Bik, 1970). The highest levels of Osmocote sometimes gave poorer growth of the plants. Osmocote increased the electrical conductivity (EC) of the soil solution, and in some cases growth inhibition due to salt accumulation is possible.

To estimate optimum soil contents of N, P and K, relative growth (i.e. the treatment with the tallest plant per experimental place and year = 100%) was plotted against soil analysis data (see for example figure 3). As N, P and K are supplied by the two compounds in a constant ratio, a real optimum can be assessed only for that nutrient which has determined growth at increased application rates the longest, probably this is nitrogen. Table 7 shows which nutrient levels in the potting soils are desired, if dressing occurs in a fixed NPK-ratio. This interpretation of soil analysis data is also dependent upon the kind of slow-release fertilizer used, in this case Osmocote. As there was a relation between growth and soil contents already in the second half of May before topdressing started, the nutrients released from Osmocote play an important role in the optimum levels as estimated.

3.5.1. Efficiency of dressing

Nursery plants, grown in containers, receive large amounts of fertilizer. At a rate of 6 g Osmocote/l potting soil with plants in 11-cm pots, 580 kg N, 195 kg P_2O_5 and 390 kg K_2O per ha are given. The usual topdressings with the NPK-compound Kristallijn, weekly 20 g/m^2, supply 720, 240 and 480 kg per ha, respectively. Because nursery plants have only a moderate demand for nutrients, an undesirable leaching loss to the environment probably takes place. Although data for a balanced account are missing, it can be roughly estimated that *Pyracantha* took up between 21-32% and *Chamaecyparis*/*Cupressocyparis* between 10-17% of the nutrients given (table 8). Together with the amount of nutrients, found by soil analysis at the end of the growing season, the recovery from the added fertilizer was for *Pyracantha* 32-73% and for the conifers 24-53%. The recovery by the plant from the two fertilizers was almost the same for N and P, but recovery of K from Kristallijn was lower, probably because this fertilizer has a higher K-content than Osmocote. At the end of the growing season a much larger amount of nutrients was present in the potting soil after application of Osmocote than after application of Kristallijn, the former giving thus less pollution through leaching.

However, the question arises what happens during winter, when precipitation is high and uptake by the plant is low. In the case of autumn planting, the higher fertility status during the period of sale, transport and delivery may be considered an advantage.

The foregoing calculation of recovery is based on the assumption that the nursery plants are grown in square pots, placed against each other and without paths. In practice, with paths and spaces between the pots, more than half of the broadcast fertilizer may be lost.

The fixed NPK-ratio of the two fertilizers was not necessarily the optimum. In the course of the growing season, the K-content of the soil, relative to that of N, increased, especially in the case of Kristallijn. Also phosphate accumulated in September. Possibly a higher content of N relative to P and K is better, especially at the end of the growing season. Currently the 8-9 months' type of Osmocote available in western Europe contains more phosphate, the NPK ratio being 18+11+10. At the beginning of growth in spring with low temperatures, release of P may be slow, and then uptake of P by the plant is also restricted. An increase in P content of the fertilizer may overcome this. The question arises whether this change is necessary for nursery plants, which have a low demand and, judging from our results, a higher level is even undesirable at the end of the season.

4. Discussion

At first sight the application of a slow-release fertilizer, which supplies nutrients as the plant needs them, has great advantages. Plants in pot with a small rooting volume can be given a larger supply at the start of the season without a great risk of burning on the one hand, and leaching and pollution of the environment on the other. One application of fertilizer mixed with the potting soil saves labour because during the growing season no special attention has to be paid to the nutrition of the plant. Permanent liquid feeding with water-soluble fertilizers also gives the possibility to keep up with the need of the plant, but after a period of heavy rains and leaching from the potting soil the necessity of dressing conflicts with the superfluity of irrigation. In the case of fairly large lots of pots, the diverse needs of the various species can be met more readily by using slow-release fertilizer than through liquid feeding, which is unsuitable for a small area. The time between mixing a slow-release fertilizer through the potting soil and planting, however, should not be too long, because otherwise salt accumulation may occur through nutrient release, with burning of the newly developing roots as a result. In view of the great number of nursery species with diverging needs of nutrition and uptake pattern, it is impossible to develop a controlled-release fertilizer that is ideal for all crops.

In several experiments Osmocote has proved its value (Manyard and Lorenz, 1979). As one species grows faster than the other, Osmocote with the most suitable rate of release should be chosen. If necessary, a mixture of formulations can be prepared. In the experiments described here, only Osmocote 18+6+12 (8-9 months'formula) was examined. By combining it with a topdressing of the water-soluble NPK-compound Kristallijn 18+6+18 in the first or second half of the growing season, it could be determined if the nutrient release starts too late or is exhausted too early. Experiments in the nursery centre Boskoop showed that 3 g Osmocote/l potting soil gave insufficient and irregular growth so that a late topdressing was necessary as a supplement

(Rijswijk, 1975). Also other slow-release fertilizers sometimes require additional topdressing (Niers, 1980). However, in our trial, late topdressing gave no or little advantage in the presence of sufficient Osmocote.

Various experiments reported in the literature deal with the question whether a basal dressing with a slow-release fertilizer can replace topdressing during the growing season. Most of them report equally good results and, according to Manyard and Lorenz (1979), even better growth and quality are obtained with controlled-release fertilizer than with liquid feeding. Trial data in Boskoop indicate, at best, equal growth (Rijswijk, 1975). In our experiments the two methods of dressing were equivalent. It depends on the price of the fertilizers, the labour saved and the investment in the nutrient application equipment which of the two methods is preferable. When a slow-release fertilizer is to be mixed through the potting soil at the beginning of the growing season, the optimum rate has to be estimated, because it is not known what the growing season will be like. In the literature, recommended doses lie between 3-4.8 g Osmocote/l potting soil. For growing tree seedlings in containers, Whitcomb (1981) mentions 3.6-5.3 g Osmocote 18+6+12 (6-9 months formulation) per litre of potting soil. In the case of topdressing with a soluble fertilizer, adjustments in the amounts applied can be made according to the rate of growth of the plants. An adjustment is also possible in the case of slow-release fertilizers by adding, during the growing season, an amount to the surface of the pot, which may give good results (Rijswijk, 1975). Intermittent drying and wetting retards the release (Lunt and Oertli, 1962). The basal dressing may also be given in this way to salt-susceptible plants (Will, 1979). With trickle irrigation, this method is less satisfactory (Coleman et al., 1978).

It could be that a specific combination of a suboptimum rate of Osmocote with liquid feeding gives better growth than each method alone. This has been reported in the literature (Coleman et al., 1978; Manyard and Lorenz, 1979), and also figure 2 points into that direction. However, if we consider all growth and quality characteristics, none of the combinations present in our experiments is clearly superior.

In both methods of dressing, approximately the same amount of nutrients was used. In practice, when the pots are not square, not placed shoulder to shoulder and when there are paths between the beds, liquid feeding leads to a much greater loss of nutrients and consequently to more pollution of the environment. At the end of the growing season, more nutrients were found in the potting soils with Osmocote. Thus this fertilizer had been more effective and caused less pollution of the environment. However, the question is what part of the material will continue to release nutrients during winter. The higher nutrient status of the potting soil may, on the other hand, be considered an advantage during the period of sale, transport, and delivery.

Excess of fertilizer, late in the season, may reduce winterhardiness of the nursery plant. Rijswijk (1978) found more winter damage after topdressing with Osmocote in mid-July. Also in the experiments described here, winterhardiness of *Pyracantha* decreased with increasing levels of Osmocote, but this was also true for late topdressing with Kristallijn.

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Table 1 - Fertilizer scheme for Osmocote and Kristallijn.

Code	Osmocote, g/l potting soil								
	Chamaecyparis, Cupressocyparis					Pyracantha			
	1974		1975 1976	1975	1976	1974		1975, 1976	
	Haren	Boskoop Horst	Haren	Boskoop Horst	Boskoop Horst	Haren	Boskoop Horst	Haren	Boskoop Horst
0.	0	0	0	0	0	0	0	0	0
1.	1.67	1.67	1.00	1.00	1.83	1.67	1.67	2.67	2.67
2.	3.34		1.83			3.34		4.33	
3.	5.00	5.00	2.67	2.67	4.33	5.00	5.00	6.00	6.00
4.	6.67		4.33			6.67		7.67	
5.	8.35	8.35	6.00	6.00	6.00	8.35	8.35	9.33	9.33
6.			7.67	7.67	7.67			11.00	11.00
7.			9.33	9.33	9.33			12.67	12.67

Code	Kristallijn, g/m/week	
	Haren	Boskoop, Horst
.0	0	0
.1	10 g, mid-May - mid-Oct, ca 22 ×	
.2	20 g, mid-May - mid-Oct, ca 22 ×	20 g, mid-May - mid-Oct, ca 22 ×
.3	10 g, mid-May - mid-Aug, ca 14 ×	
.4	20 g, mid-May - mid-Aug, ca 14 ×	20 g, mid-May - mid-Aug, ca 14 ×
.5	10 g, mid-Aug - mid-Oct, ca 8 ×	
.6	20 g, mid-Aug - mid-Oct, ca 8 ×	20 g, mid-Aug - mid-Oct, ca 8 ×

Table 2 - Effect of quantity of Kristallijn 18+6+18 on plant height at the end of the growing season in Haren.

Year	Without Osmocote		With Osmocote		Statistical evaluation		
					stat. significant*)		least significant difference at P = 0.05
	10 g/m^2	20 g/m^2	10 g/m^2	20 g/m^2	quant. × osm.	quant.	
	Chamaecyparis, Cupressocyparis						
1974	35 cm	36 cm	35 cm	36 cm	-	+++	1 cm
1975	31	31	31	31	+	-	1
1976	57	55	62	62	-	-	2
	Pyracantha						
1974	48	55	57	59	+	+	2
1975	48	56	68	70	+++	+++	2
1976	70	78	92	95	+	++	2

*) statistically significant at P = 0.05 : +; P = 0.01 : ++ and P = 0.001 : +++

Table 3 - Effect of Osmocote or Kristallijn alone on plant height (cm).

Place	Year	Osmocote without Krist.		Kristallijn without Osmocote			Statistical evaluation		
							stat. sign.		least sign. diff. P = 0.05 between Osm. and Krist.
		optimum g/l	maximum height	early	late	contin.	Krist. with/ without	Osm. quadr. comp.	
		Chamaecyparis, Cupressocyparis							
Boskoop	1974	5.6	39 cm	35 cm	33 cm	35 cm	-	-	11 cm
Haren	1974	0	35	38	34	36	+++	-	3
Horst	1974	4.2	38	36	41	39	-	+	3
Boskoop	1975	4.7	29	30	28	30	-	+	2
Haren	1975	4.6	32	32	29	31	-	++	3
Horst	1975	0	37	36	38	37	-	-	2
Boskoop	1976	6.4	53	50	41	56	+++	+++	5
Haren	1976	5.9	67	58	50	57	+++	+++	7
Horst	1976	6.5	55	55	53	57	++	+++	4
		Pyracantha							
Boskoop	1974	6.9	88	73	45	74	+	-	15
Haren	1974	5.8	62	59	41	67	-	+	10
Horst	1974	5.9	78	74	64	72	-	+	14
Boskoop	1975	9.0	91	71	34	93	+++	+++	11
Haren	1975	8.7	77	67	25	76	+++	+++	7
Horst	1975	8.1	96	87	68	91	++	+++	8
Boskoop	1976	9.2	109	87	47	103	+++	+++	13
Haren	1976	8.8	99	85	49	101	+++	+++	10
Horst	1976	8.1	84	74	83	85	+++	+++	10

Table 4 - Effect of topdressing with Kristallijn, at the optimum level of Osmocote as basal dressing, on height of plant (cm).

Place	Year	Kristallijn topdressing			Statistical evaluation	
		early	late	contin.	interaction Osm. × Krist.	least sign. difference P = 0.05
		Chamaecyparis, Cupressocyparis				
Boskoop	1974	- 0.5 cm	- 0.5 cm	- 2.0	-	11.3 cm
Haren	1974	+ 2.0	- 1.2	+ 0.8	-	2.6
Horst	1974	- 0.1	+ 1.5	+ 1.6	++	3.2
Boskoop	1975	+ 1.0	+ 0.3	+ 1.8	-	2.0
Haren	1975	- 1.7	- 1.6	- 2.6	-	2.9
Horst	1975	- 0,9	+ 1.2	+ 0.4	-	2.2
Boskoop	1976	- 4.5	0	+ 0.3	+++	4.9
Haren	1976	+ 2.1	0	- 1.4	+++	6.8
Horst	1976	+ 0.5	+ 1.5	+ 1.2	+	4.3
		Pyracantha				
Boskoop	1974	- 1.0	+ 3.0	- 3.5	-	14.7
Haren	1974	+ 1.0	- 4.6	+ 4.1	+++	9.9
Horst	1974	- 5.4	- 6.2	- 3.3	+	13.7
Boskoop	1975	- 2.5	+ 6.8	+ 3.5	+++	10.9
Haren	1975	- 7.7	- 5.2	- 2.0	+++	6.5
Horst	1975	- 6.4	+ 0.2	- 4.7	+++	8.3
Boskoop	1976	- 2.3	+ 9.5	+ 0.3	+++	13.2
Haren	1976	+ 7.3	+ 8.6	+ 6.1	+++	10.0
Horst	1976	+ 8.5	+ 14.1	+ 9.5	-	9.7

Table 5 - *Effect of Osmocote and Kristallijn on winterhardiness of* Pyracantha.

Place	Year (spring)	Osmocote rates, code, without Kristallijn							Kristallijn topdressing, without Osm.			
		0.	1.	3.	5.	6.	7.	stat. eval. lin. comp.	early	late	contin.	stat. eval. with/without
Boskoop	1975	3.8	3.0	3.8	3.2*)			n.c.**)	3.3	4.0	3.3	n.c.
Haren	1975	4.3	3.6	4.0	3.9			-	4.1	3.8	4.3	-
Horst	1975	3.7	3.8	2.9	2.6			n.c.	3.4	3.5	3.2	n.c.
Boskoop	1976	2.4	3.3	3.0	3.7	3.5	2.8	n.c.	3.2	1.3	3.9	n.c.
Haren	1976	1.4	1.5	2.3	0.4	0.8	0.1	++	2.4	0.5	1.7	+
Horst	1976	3.5	3.4	3.4	3.3	3.4	3.1	n.c.	3.7	3.1	3.0	n.c.
Boskoop	1977	4.0	4.2	4.1	3.5	3.7	3.4	+	3.6	4.2	4.2	+
Haren	1977	3.8	3.9	3.1	3.6	2.8	3.1	+	3.6	2.7	4.0	+
Horst	1977	3.2	2.6	1.5	1.7	1.5	1.5	+++	3.2	3.0	2.3	-

*) rating for new rootlets in spring: 0 = no new roots; 5 = very good new rooting
**) n.c. = not calculated

Table 6 - Effect of Osmocote and Kristallijn on N-content of soil (mmol N in soil-water extract 1:1.5, v/v).

Period of sampling	Effect of Osmocote for two levels					
	1974		1975		1976	
	0.	5.	0.	5.	0.	5.
End of May	4.2	8.4	0.7	3.6	2.6	15.0
Mid-August	0.9	12.6	1.6	11.6	1.7	12.5
Mid-September	0.5	5.8	1.4	8.8	1.1	7.5
	Effect of Kristallijn for two levels					
	1974		1975		1976	
	no	contin.	no	contin.	no	contin.
Mid-August	5.7	7.7	7.0	7.4	7.3	7.8
Mid-September	2.5	4.1	4.3	5.1	4.9	6.6

Table 7 - Optimum soil contents of N, P and K in the 1:1.5 soil-water extract in August and September, derived from graphs relating relative growth to soil contents. Dressing with two fixed-ratio NPK-compounds, one a slow-release fertilizer.

Element	Period	Pyracantha			Chamaecyparis, Cupressocyparis		
		1974	1975	1976	1974	1975	1976
N mmol/l extract	August	6.5	7.5	6.5		2.3	3.5
	September	2.5	3.5	3.0	0.2	2.3	2.5
P mmol/l	August	0.65	0.58	0.68		0.24	0.32
	September	0.34	0.32	0.32		0.24	0.29
K mmol/l	August	2.8	2.8	3.3	1.5	0.8	1.3
	September	1.8	1.8	2.0	0.8	1.3	1.5

Table 8 - Recovery of fertilizer by the plant and amount remaining in the potting soils at the end of the growing season, as percentage of supply.

Element	Recovered nutrient in	Osmocote		Kristallijn	
		Pyrac.	Cham.-Cupr.	Pyrac.	Cham.-Cupr.
N	plant	32 %	17 %	32 %	15 %
	plant + soil	51	37	34	24
P	plant	21	16	24	17
	plant + soil	51	46	32	31
K	plant	30	15	23	10
	plant + soil	73	53	45	34

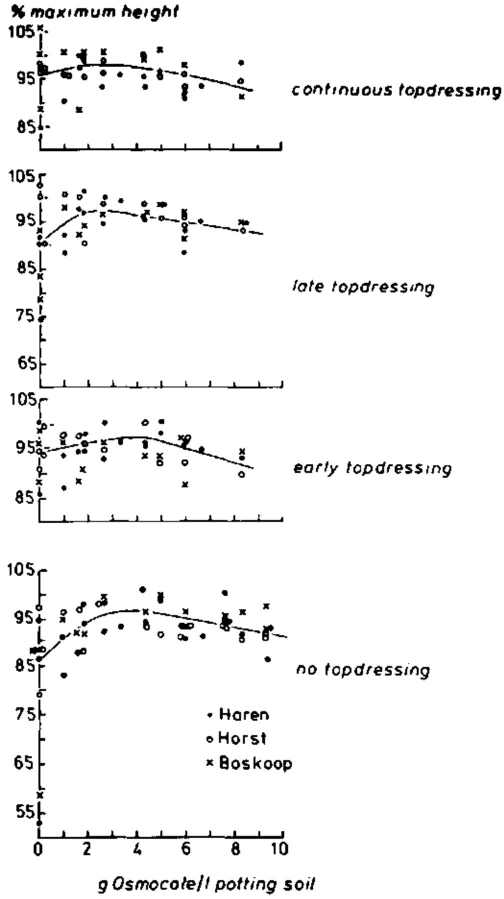

Figure 1 - Relative growth of Chamaecyparis/Cupressocyparis as affected by Osmocote level, mixed through potting soil, and topdressing with Kristallijn.

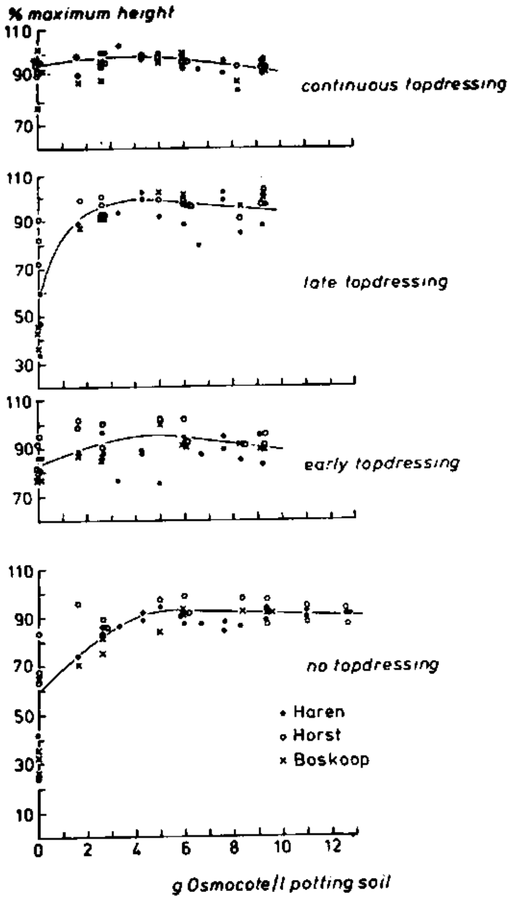

Figure 2 - Relative growth of Pyracantha as affected by Osmocote level, mixed through potting soil, and topdressing with Kristallijn.

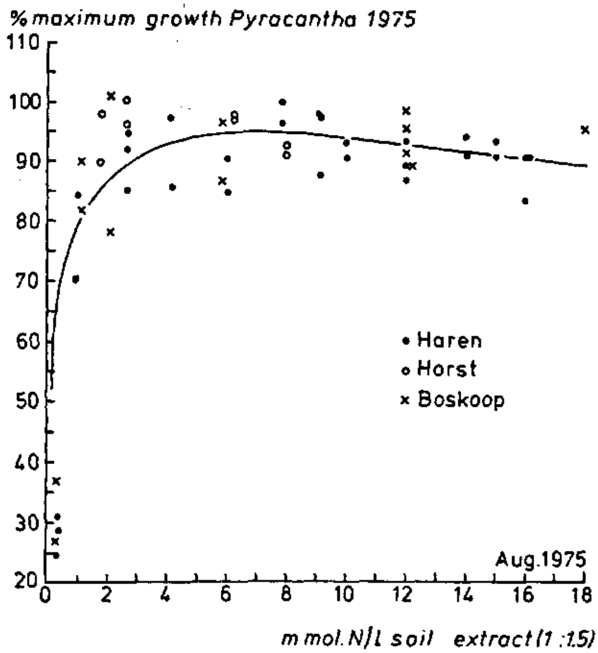

Figure 3 - Relative growth of Pyracantha in 1975 as affected by N-content of the potting soil in August.