Nutrient Allocation From CRFs in #1 Containers During a One-Year Production Cycle in Riverside, CA

By

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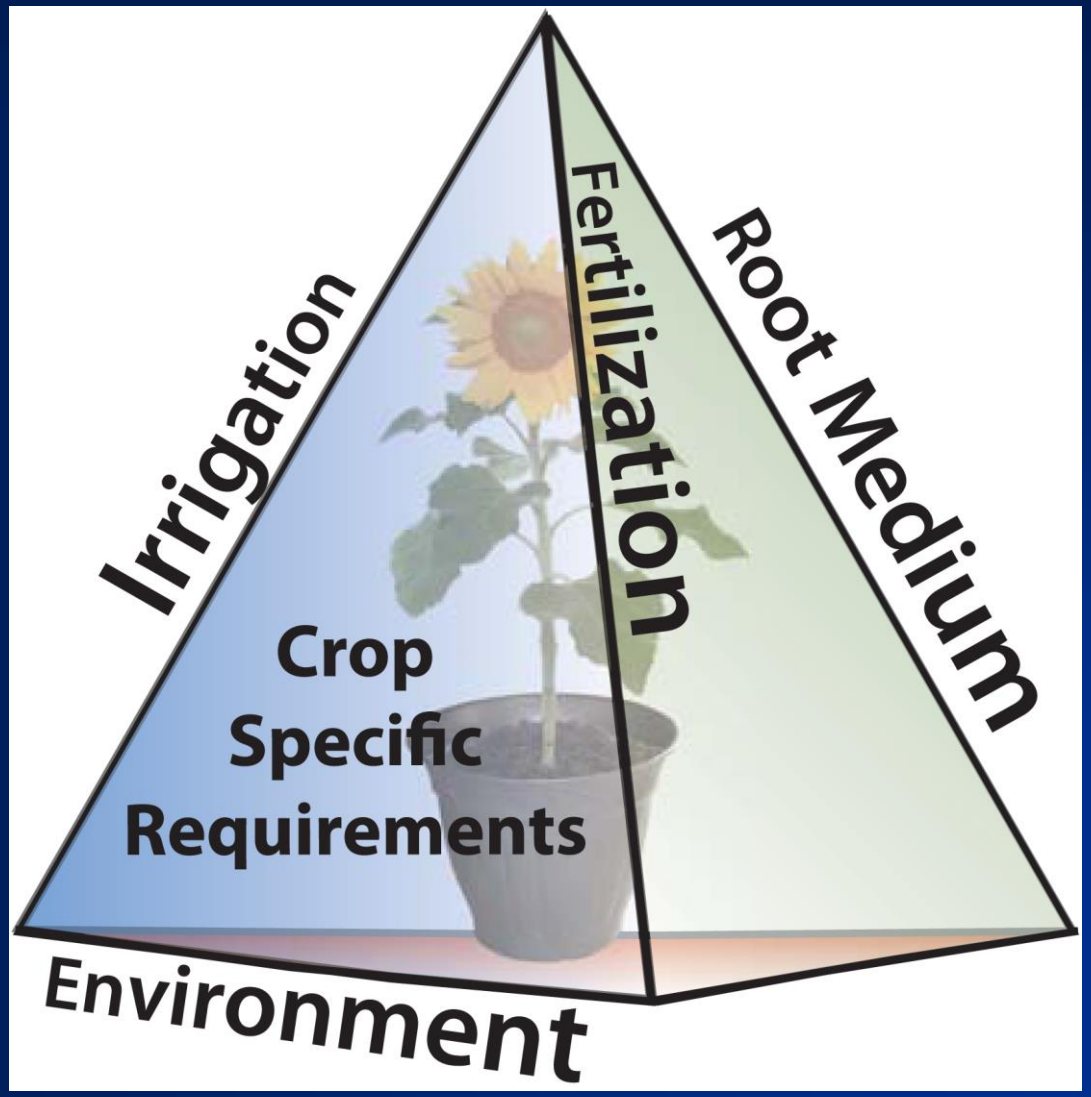
*California Department of Food and Agriculture (CDFA)

*California Association of Nurseries and Garden Centers (CANGC)

*NC1186 Water Management and Quality for Specialty Crop Production and Health

Nutrient Management Pyramid



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Variables influencing fertilizer availability and uptake into plants:

1. Environment
2. Plant
3. Media
4. Water/Irrigation

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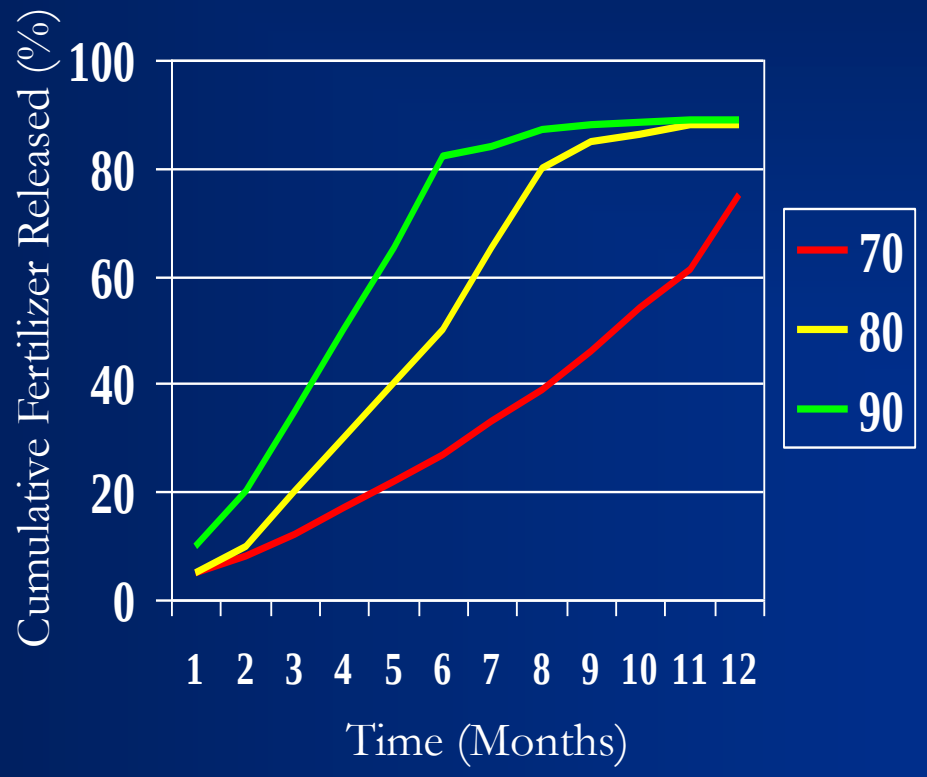
Environment - Temperature
Controlled Release Fertilizers (CRF)

*Nutrient release based on coating thickness and/or coating makeup

*Release rates increase with increase temperature and/or moisture



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Variables influencing fertilizer availability and uptake into plants:

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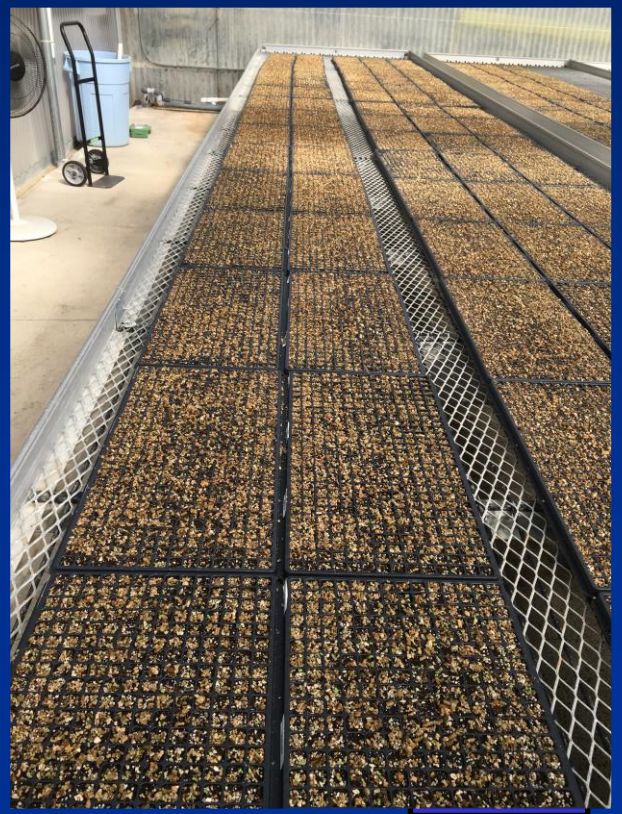
Plant Palette



Variables influencing fertilizer availability and uptake into plants:

1. Environment
2. Plant
3. Media
4. Water/Irrigation

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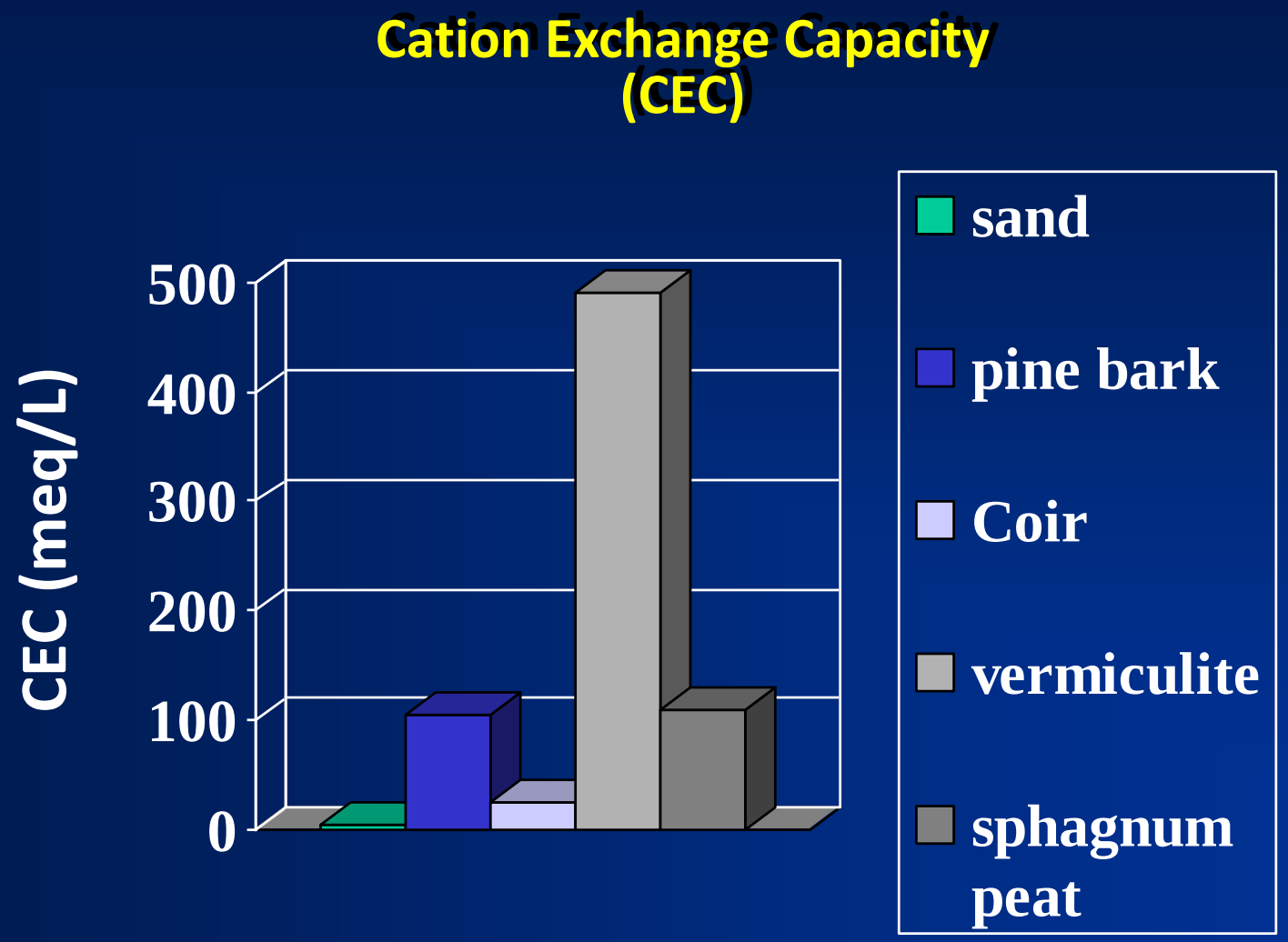
Limitations of Media

Mg^{2+}, K^{+}, Ca^{2+}



Variables influencing fertilizer availability and uptake into plants:

1. Environment
2. Plant
3. Media
4. Water/Irrigation

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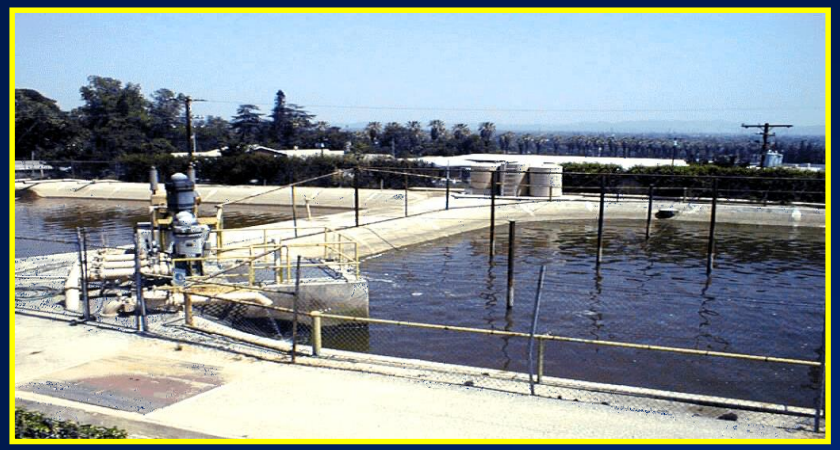
Water Quality and Irrigation Method



Water quality – alkalinity, EC

Affects nutrient availability – especially liquid feed

Irrigation method

***overhead vs. drip**

***frequency of irrigation**

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Nitrogen Release and Uptake Into Plants from Different Controlled Release Fertilizers (CRF)

1. Apex
2. Multicote
3. Nutricote
4. Osmocote

Overview:

1. How much fertilizer is released?
2. When is fertilizer released?
3. Where does the fertilizer go? – plant or leachate

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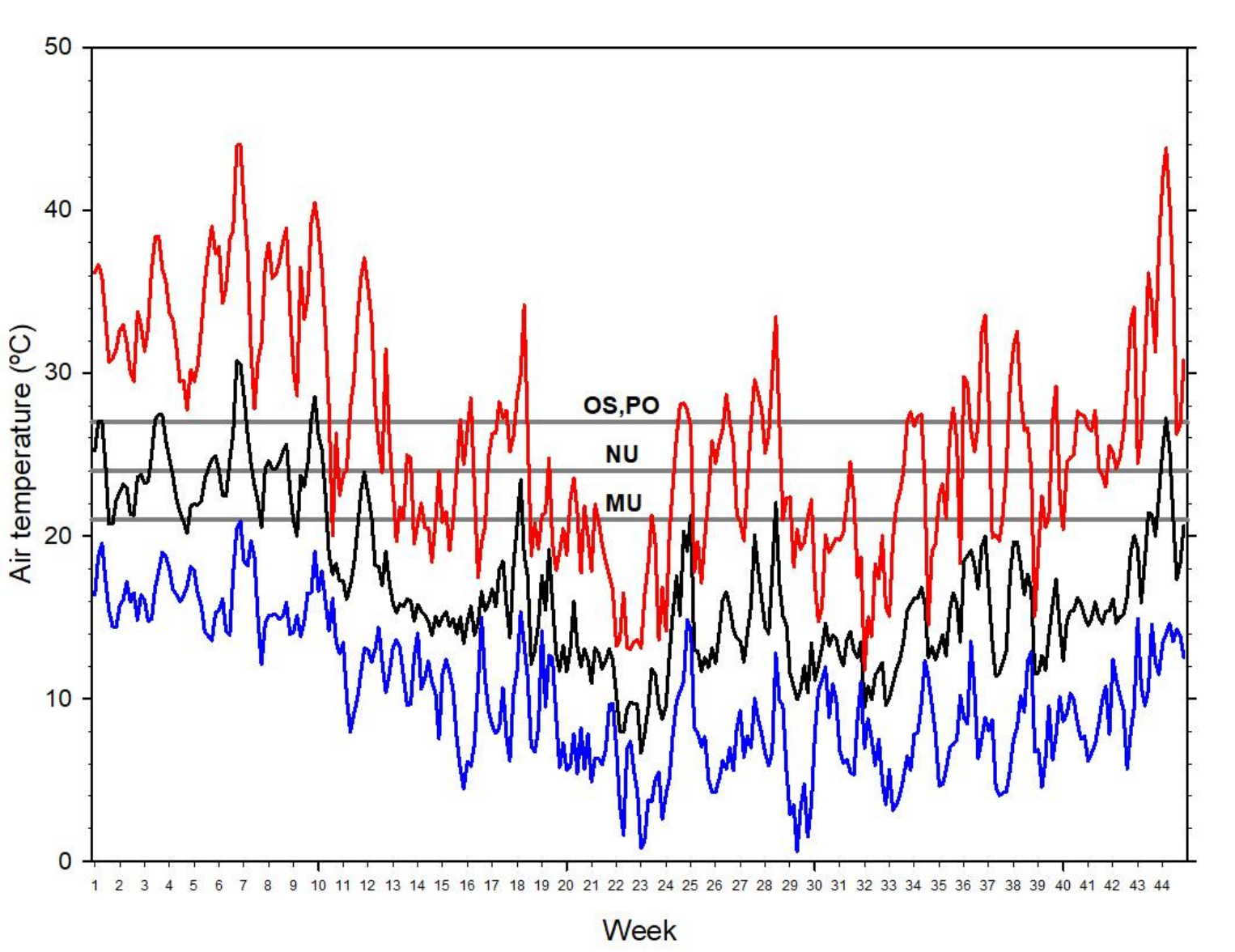
- 6.22, 3.11 grams Nitrogen/container
- Incorporated into media
- Drip Irrigation – ring drippers
- 11 month production cycle
- All Leachates collected weekly
- Plants harvested monthly


Air temperature (°C)
Week
OS,PO
NU
MU
0
10
20
30
40
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44

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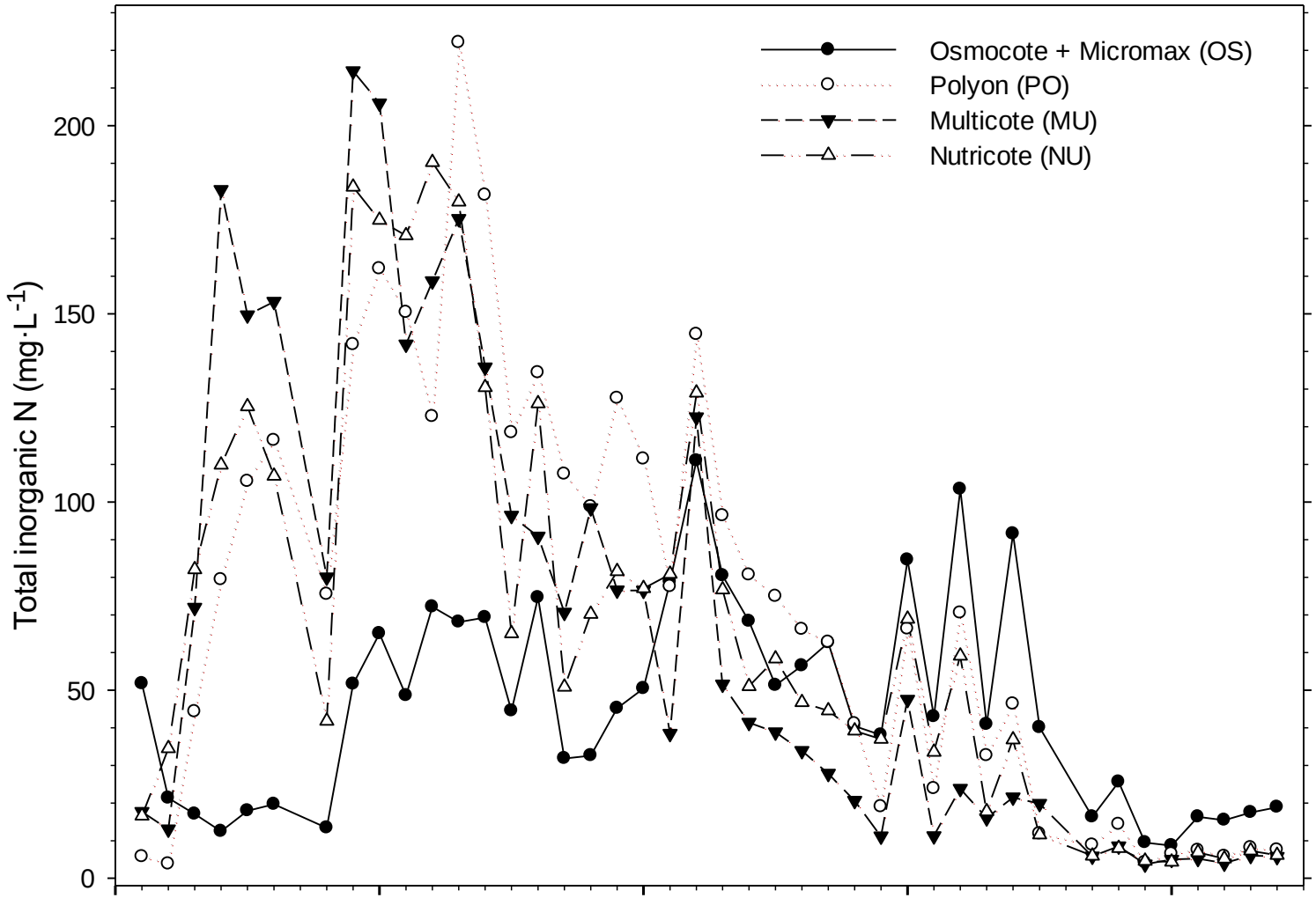
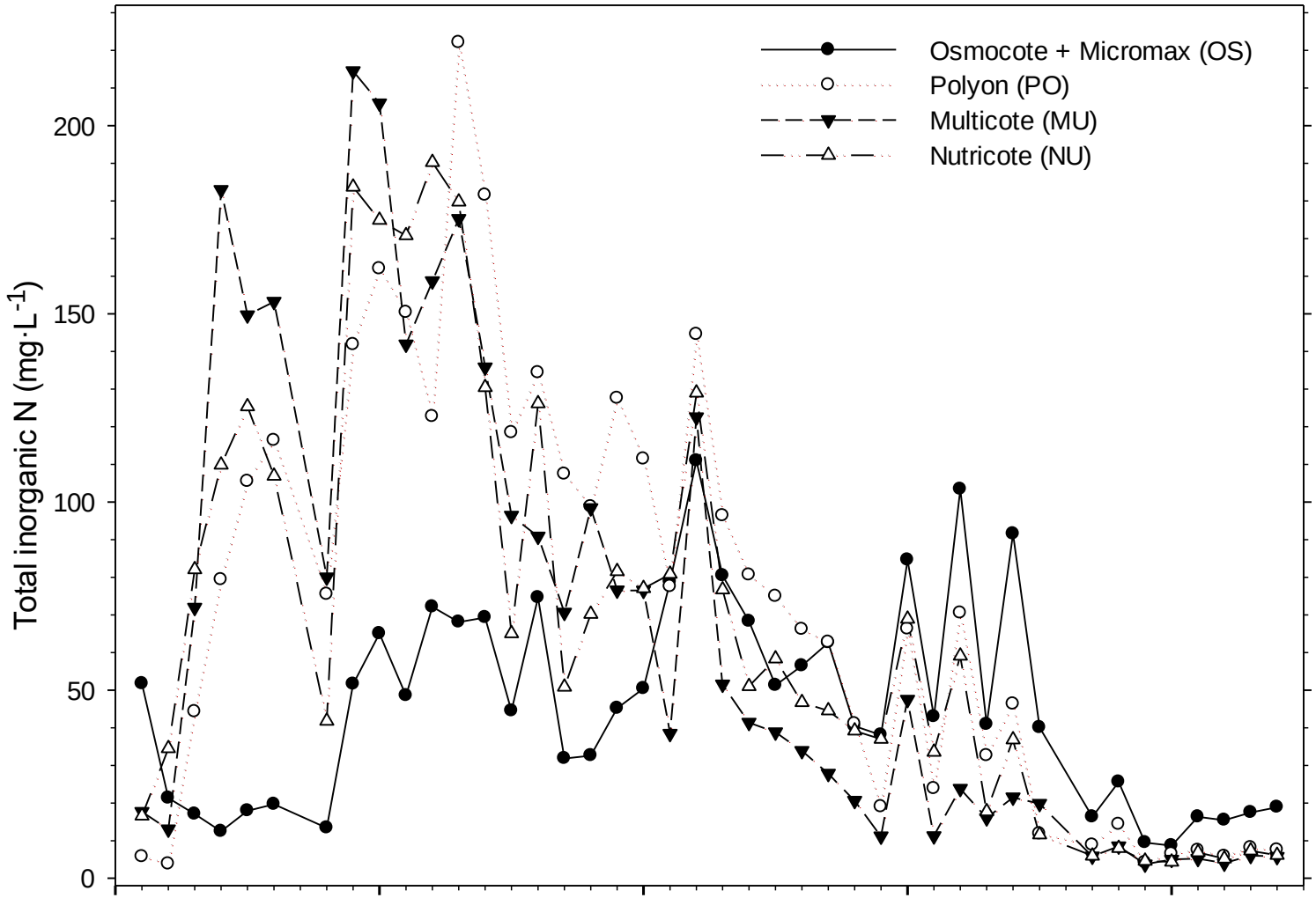
Nitrogen allocation for #1 container plants

Total Inorganic nitrogen in Leachate for Ligustrum during a 11 month growing cycle



Week:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
OS:PO	+	+	–	–	–	–		–	–	–	–	·	–	–	–	·	–	·	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·		+	+	+	·	+	+	+	+
OS:MU	+	·	–	–	–	–		–	–	–	–	–	–	–	–	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	+	+	·	+	·		+	+	+	·	+	+	+	+
OS:NU	+	·	–	–	–	–		–	–	–	–	–	–	–	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·		+	+	+	·	+	+	+	+
PO:OS	–	–	+	+	+	+		+	+	+	+	·	+	+	+	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	–	·		–	–	–	·	–	–	–	–
PO:MU	·	·	–	–	·	·		·	–	·	·	·	+	+	·	·	·	·	·	·	+	·	+	+	·	·	·	·	·	·	·	+	·	·	·		·	·	·	·	·	·	·	·
PO:NU	·	–	–	–	·	·		+	·	·	·	–	+	+	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
MU:OS	–	·	+	+	+	+		+	+	+	+	+	+	+	+	·	·	·	·	·	–	·	·	·	·	·	·	·	·	·	–	–	·	–	·		–	–	–	·	–	–	–	–
MU:PO	·	·	+	+	·	·		·	+	·	·	·	–	–	·	·	·	·	·	·	–	·	–	–	·	·	·	·	·	·	·	–	·	·	·		·	·	·	·	·	·	·	·
MU:NU	·	–	·	+	·	·		+	·	·	·	·	·	·	+	·	·	·	·	·	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
NU:OS	–	·	+	+	+	+		+	+	+	+	+	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	–	·	–	·		–	–	–	·	–	–	–	–
NU:PO	·	+	+	+	·	·		–	·	·	·	+	–	–	–	·	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
NU:MU	·	+	·	–	·	·		–	·	·	·	·	·	·	–	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·

Total Inorganic nitrogen in Leachate for Ligustrum during a 11 month growing cycle



Week:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
OS:PO	+	+	–	–	–	–		–	–	–	–	·	–	–	–	·	–	·	–		·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·		+	+	+	·	+	+	+	+
OS:MU	+	·	–	–	–	–		–	–	–	–	–	–	–	–	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	+	+	·	+	·		+	+	+	·	+	+	+	+
OS:NU	+	·	–	–	–	–		–	–	–	–	–	–	–	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·		+	+	+	·	+	+	+	+
PO:OS	–	–	+	+	+	+		+	+	+	+	·	+	+	+	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	–	·		–	–	–	·	–	–	–	–
PO:MU	·	·	–	–	·	·		·	–	·	·	·	+	+	·	·	·	·	·	·	+	·	+	+	·	·	·	·	·	·	·	+	·	·	·		·	·	·	·	·	·	·	·
PO:NU	·	–	–	–	·	·		+	·	·	·	–	+	+	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
MU:OS	–	·	+	+	+	+		+	+	+	+	+	+	+	+	·	·	·	·	·	–	·	·	·	·	·	·	·	·	·	–	–	·	–	·		–	–	–	·	–	–	–	–
MU:PO	·	·	+	+	·	·		·	+	·	·	·	–	–	·	·	·	·	·	·	–	·	–	–	·	·	·	·	·	·	·	–	·	·	·		·	·	·	·	·	·	·	·
MU:NU	·	–	·	+	·	·		+	·	·	·	·	·	·	+	·	·	·	·	·	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
NU:OS	–	·	+	+	+	+		+	+	+	+	+	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	–	·	–	·		–	–	–	·	–	–	–	–
NU:PO	·	+	+	+	·	·		–	·	·	·	+	–	–	–	·	–	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
NU:MU	·	+	·	–	·	·		–	·	·	·	·	·	·	–	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·

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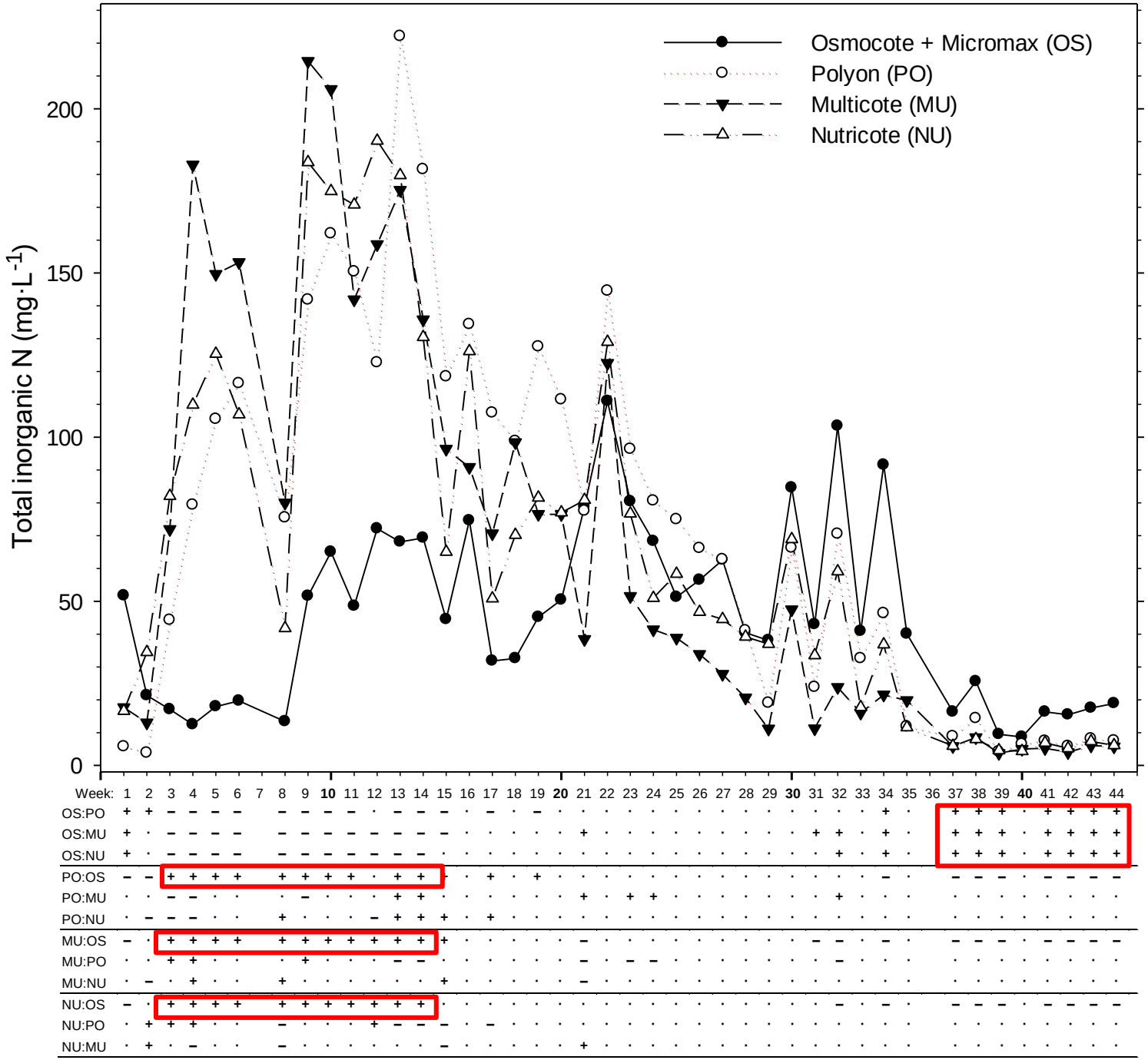
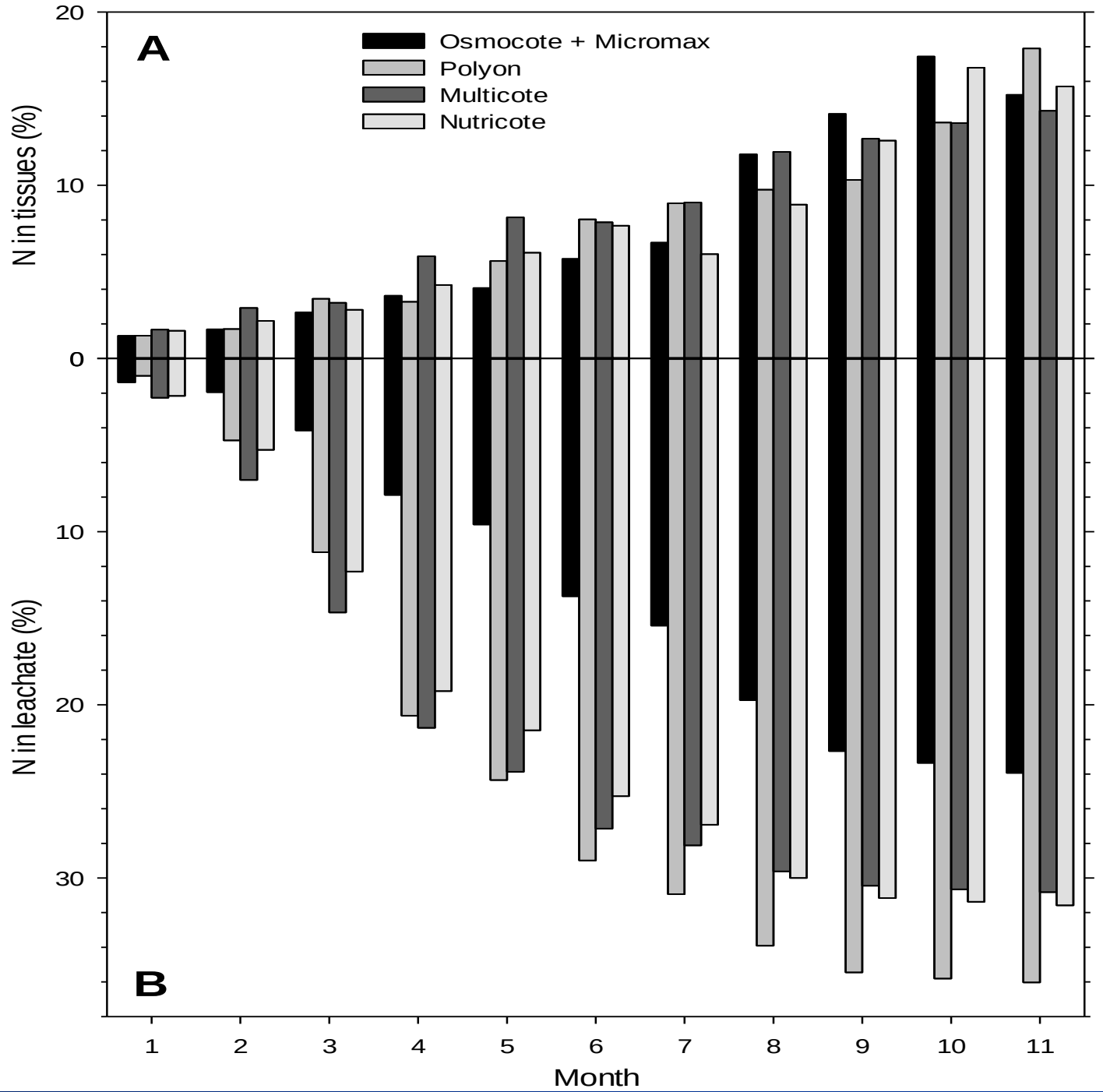
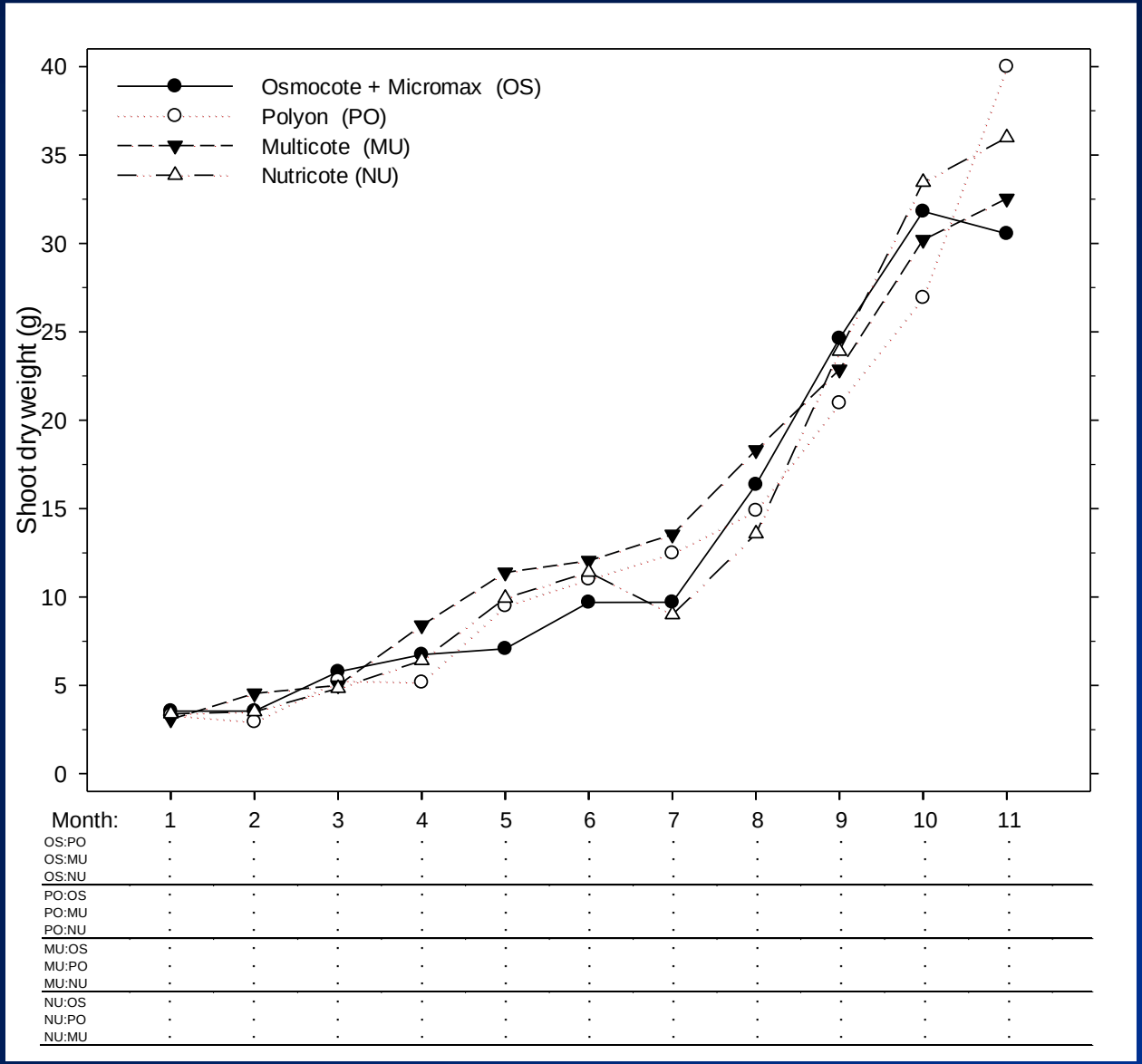


How much nitrogen was taken up by the plant?

Percentage of nitrogen in plants (shoots and roots) and leachates for each month of the 11 month growth cycle

Ligustrum




Osmocote + Micromax (OS)
Polyon (PO)
Multicote (MU)
Nutricote (NU)
Shoot dry weight (g)
0
5
10
15
20
25
30
35
40
Month:
1
2
3
4
5
6
7
8
9
10
11
OS:PO
OS:MU
OS:NU
PO:OS
PO:MU
PO:NU
MU:OS
MU:PO
MU:NU
NU:OS
NU:PO
NU:MU

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Cumulative % of nitrogen recovered in Tissue and leachates for 11 months

CRF	Month										
	1	2	3	4	5	6	7	8	9	10	11
	Tissues										
Osmocote + Micromax	1.3 a[z]	1.7 b	2.7 a	3.6 b	4.1 b	5.8 a	6.7 a	11.8 a	14.1 a	17.4 a	15.2 a
Polyon	1.3 a	1.7 b	3.5 a	3.3 b	5.6 ab	8.0 a	9.0 a	9.7 a	10.3 a	13.6 a	17.9 a
Multicote	1.7 a	2.9 a	3.2 a	5.9 a	8.1 a	7.9 a	9.0 a	11.9 a	12.7 a	13.6 a	14.3 a
Nutricote	1.6 a	2.2 ab	2.8 a	4.2 ab	6.1 ab	7.7 a	6.0 a	8.9 a	12.6 a	16.8 a	15.7 a
	Leachate										
Osmocote + Micromax	1.4 b	1.9 c	4.2 c	7.9 b	9.6 b	13.7 c	15.4 c	19.7 c	22.7 c	23.4 c	23.9 c
Polyon	1.0 b	4.7 b	11.2 b	20.6 a	24.4 a	29.0 a	30.9 a	33.9 a	35.5 a	35.8 a	36.0 a
Multicote	2.3 a	7.0 a	14.7 a	21.3 a	23.9 a	27.1 ab	28.1 b	29.6 b	30.4 b	30.7 b	30.8 b
Nutricote	2.2 a	5.3 b	12.3 b	19.2 a	21.5 a	25.3 b	26.9 b	30.0 b	31.2 b	31.4 b	31.6 b

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Cumulative % of nitrogen recovered in Tissue and leachates for 11 months

CRF	Month										
	1	2	3	4	5	6	7	8	9	10	11
	Tissues										
Osmocote + Micromax	1.3 a[z]	1.7 b	2.7 a	3.6 b	4.1 b	5.8 a	6.7 a	11.8 a	14.1 a	17.4 a	15.2 a
Polyon	1.3 a	1.7 b	3.5 a	3.3 b	5.6 ab	8.0 a	9.0 a	9.7 a	10.3 a	13.6 a	17.9 a
Multicote	1.7 a	2.9 a	3.2 a	5.9 a	8.1 a	7.9 a	9.0 a	11.9 a	12.7 a	13.6 a	14.3 a
Nutricote	1.6 a	2.2 ab	2.8 a	4.2 ab	6.1 ab	7.7 a	6.0 a	8.9 a	12.6 a	16.8 a	15.7 a
	Leachate										
Osmocote + Micromax	1.4 b	1.9 c	4.2 c	7.9 b	9.6 b	13.7 c	15.4 c	19.7 c	22.7 c	23.4 c	23.9 c
Polyon	1.0 b	4.7 b	11.2 b	20.6 a	24.4 a	29.0 a	30.9 a	33.9 a	35.5 a	35.8 a	36.0 a
Multicote	2.3 a	7.0 a	14.7 a	21.3 a	23.9 a	27.1 ab	28.1 b	29.6 b	30.4 b	30.7 b	30.8 b
Nutricote	2.2 a	5.3 b	12.3 b	19.2 a	21.5 a	25.3 b	26.9 b	30.0 b	31.2 b	31.4 b	31.6 b

UCCE

Cumulative % of nitrogen recovered in Tissue and leachates for 11 months

CRF	Month										
	1	2	3	4	5	6	7	8	9	10	11
	Tissues										
Osmocote + Micromax	1.3 a[z]	1.7 b	2.7 a	3.6 b	4.1 b	5.8 a	6.7 a	11.8 a	14.1 a	17.4 a	15.2 a
Polyon	1.3 a	1.7 b	3.5 a	3.3 b	5.6 ab	8.0 a	9.0 a	9.7 a	10.3 a	13.6 a	17.9 a
Multicote	1.7 a	2.9 a	3.2 a	5.9 a	8.1 a	7.9 a	9.0 a	11.9 a	12.7 a	13.6 a	14.3 a
Nutricote	1.6 a	2.2 ab	2.8 a	4.2 ab	6.1 ab	7.7 a	6.0 a	8.9 a	12.6 a	16.8 a	15.7 a
	Leachate										
Osmocote + Micromax	1.4 b	1.9 c	4.2 c	7.9 b	9.6 b	13.7 c	15.4 c	19.7 c	22.7 c	23.4 c	23.9 c
Polyon	1.0 b	4.7 b	11.2 b	20.6 a	24.4 a	29.0 a	30.9 a	33.9 a	35.5 a	35.8 a	36.0 a
Multicote	2.3 a	7.0 a	14.7 a	21.3 a	23.9 a	27.1 ab	28.1 b	29.6 b	30.4 b	30.7 b	30.8 b
Nutricote	2.2 a	5.3 b	12.3 b	19.2 a	21.5 a	25.3 b	26.9 b	30.0 b	31.2 b	31.4 b	31.6 b

UCCE

Cumulative % of nitrogen recovered in Tissue and leachates for 11 months

CRF	Month										
	1	2	3	4	5	6	7	8	9	10	11
	Tissues										
Osmocote + Micromax	1.3 a[z]	1.7 b	2.7 a	3.6 b	4.1 b	5.8 a	6.7 a	11.8 a	14.1 a	17.4 a	15.2 a
Polyon	1.3 a	1.7 b	3.5 a	3.3 b	5.6 ab	8.0 a	9.0 a	9.7 a	10.3 a	13.6 a	17.9 a
Multicote	1.7 a	2.9 a	3.2 a	5.9 a	8.1 a	7.9 a	9.0 a	11.9 a	12.7 a	13.6 a	14.3 a
Nutricote	1.6 a	2.2 ab	2.8 a	4.2 ab	6.1 ab	7.7 a	6.0 a	8.9 a	12.6 a	16.8 a	15.7 a
	Leachate										
Osmocote + Micromax	1.4 b	1.9 c	4.2 c	7.9 b	9.6 b	13.7 c	15.4 c	19.7 c	22.7 c	23.4 c	23.9 c
Polyon	1.0 b	4.7 b	11.2 b	20.6 a	24.4 a	29.0 a	30.9 a	33.9 a	35.5 a	35.8 a	36.0 a
Multicote	2.3 a	7.0 a	14.7 a	21.3 a	23.9 a	27.1 ab	28.1 b	29.6 b	30.4 b	30.7 b	30.8 b
Nutricote	2.2 a	5.3 b	12.3 b	19.2 a	21.5 a	25.3 b	26.9 b	30.0 b	31.2 b	31.4 b	31.6 b

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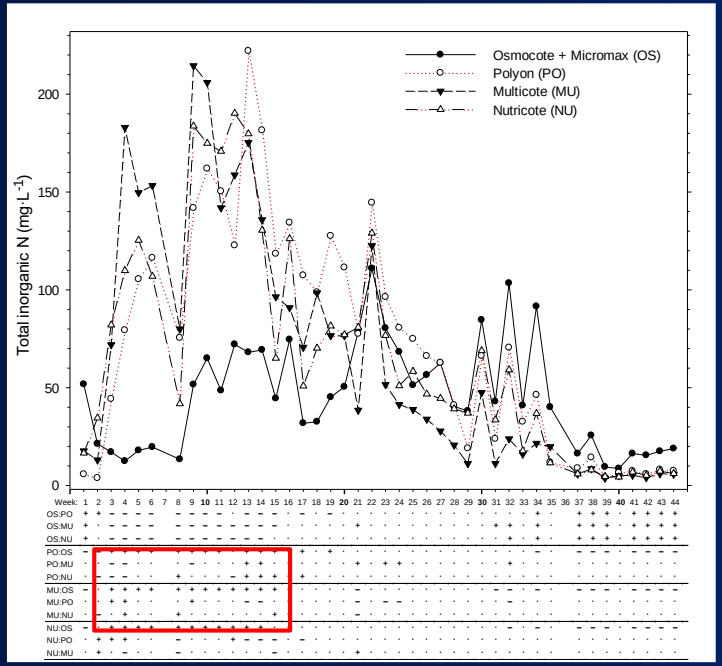
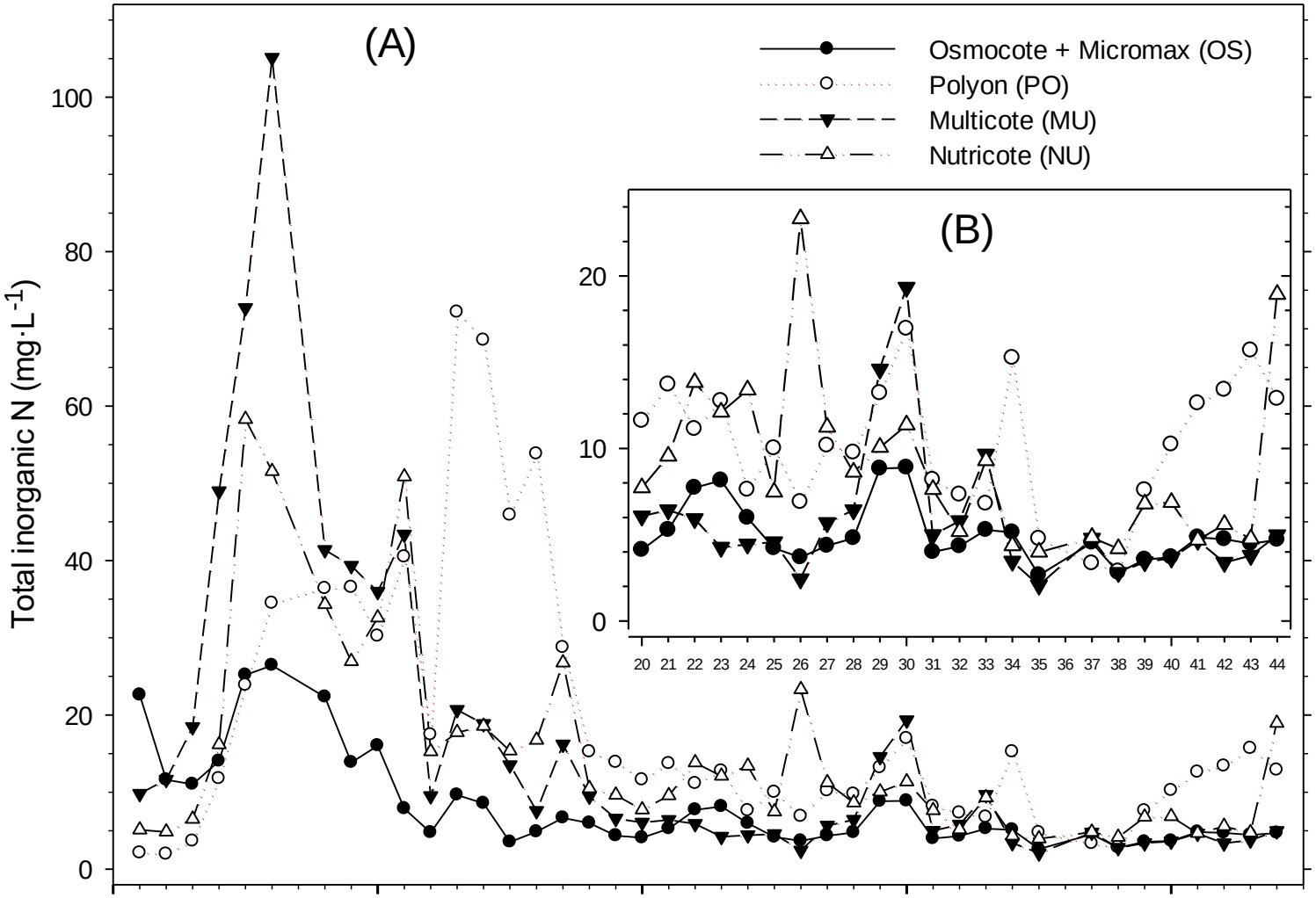
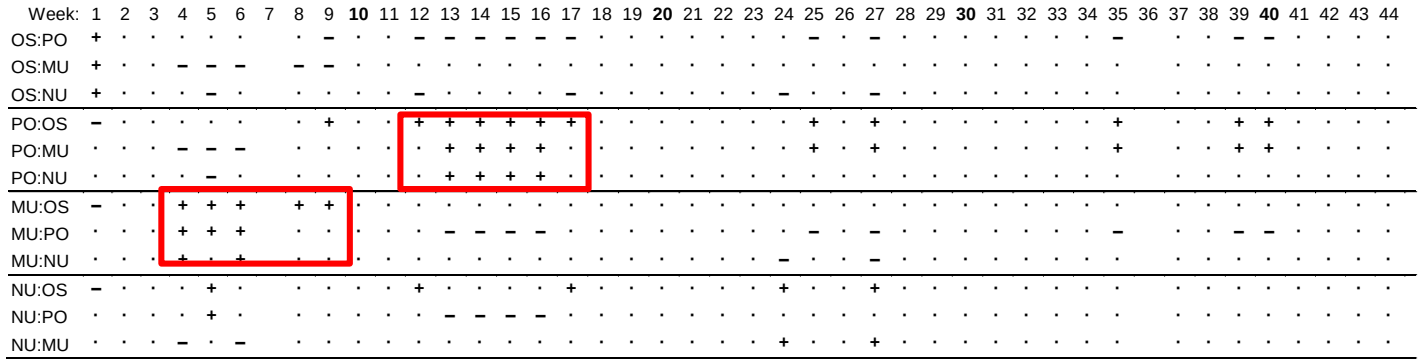
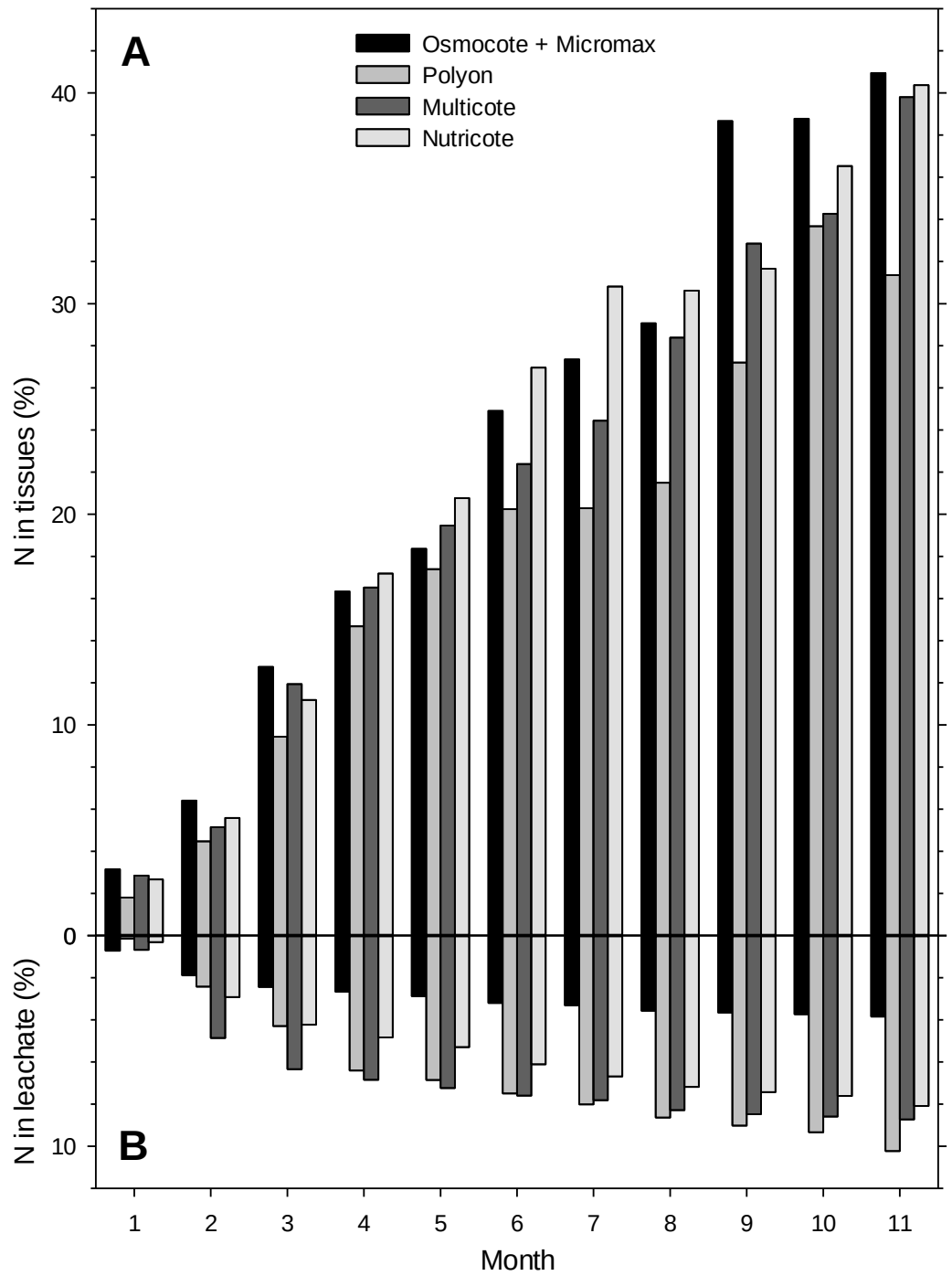
Total Inorganic nitrogen in Leachate for Azalea during a 11 month growing cycle









% of Fertilizer nitrogen allocated to plants and leachate

Plant Tissues

Azalea

Leachate

Cumulative % of nitrogen recovered in Tissue and leachates for 11 months

Azalea

CRF	Month										
	1	2	3	4	5	6	7	8	9	10	11
	Tissues										
Osmocote + Micromax	3.1 a[z]	6.4 a	12.8 a	16.3 a	18.4 a	24.9 ab	27.4 a	29.1 a	38.7 a	38.8 a	40.9 a
Polyon	1.8 b	4.5 a	9.4 b	14.7 a	17.4 a	20.2 c	20.3 b	21.5 b	27.2 a	33.7 a	31.4 b
Multicote	2.8 a	5.1 a	11.9 ab	16.5 a	19.5 a	22.4 bc	24.4 ab	28.4 a	32.9 a	34.3 a	39.8 a
Nutricote	2.7 a	5.6 a	11.2 ab	17.2 a	20.8 a	27.0 a	30.8 a	30.6 a	31.7 a	36.5 a	40.4 a
	Leachate										
Osmocote + Micromax	0.7 a	1.9 b	2.4 c	2.7 c	2.9 c	3.2 b	3.3 b	3.6 b	3.7 b	3.7 b	3.9 b
Polyon	0.1 b	2.4 b	4.3 b	6.4 a	6.9 a	7.5 a	8.0 a	8.6 a	9.0 a	9.3 a	10.2 a
Multicote	0.7 a	4.9 a	6.3 a	6.9 a	7.2 a	7.6 a	7.8 a	8.3 a	8.5 a	8.6 a	8.7 a
Nutricote	0.3 ab	2.9 b	4.2 b	4.8 b	5.3 b	6.1 a	6.7 a	7.2 a	7.4 a	7.6 a	8.1 a

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Cumulative % of nitrogen recovered in Tissue and leachates for 11 months

Azalea

CRF	Month										
	1	2	3	4	5	6	7	8	9	10	11
	Tissues										
Osmocote + Micromax	3.1 a[z]	6.4 a	12.8 a	16.3 a	18.4 a	24.9 ab	27.4 a	29.1 a	38.7 a	38.8 a	40.9 a
Polyon	1.8 b	4.5 a	9.4 b	14.7 a	17.4 a	20.2 c	20.3 b	21.5 b	27.2 a	33.7 a	31.4 b
Multicote	2.8 a	5.1 a	11.9 ab	16.5 a	19.5 a	22.4 bc	24.4 ab	28.4 a	32.9 a	34.3 a	39.8 a
Nutricote	2.7 a	5.6 a	11.2 ab	17.2 a	20.8 a	27.0 a	30.8 a	30.6 a	31.7 a	36.5 a	40.4 a
	Leachate										
Osmocote + Micromax	0.7 a	1.9 b	2.4 c	2.7 c	2.9 c	3.2 b	3.3 b	3.6 b	3.7 b	3.7 b	3.9 b
Polyon	0.1 b	2.4 b	4.3 b	6.4 a	6.9 a	7.5 a	8.0 a	8.6 a	9.0 a	9.3 a	10.2 a
Multicote	0.7 a	4.9 a	6.3 a	6.9 a	7.2 a	7.6 a	7.8 a	8.3 a	8.5 a	8.6 a	8.7 a
Nutricote	0.3 ab	2.9 b	4.2 b	4.8 b	5.3 b	6.1 a	6.7 a	7.2 a	7.4 a	7.6 a	8.1 a

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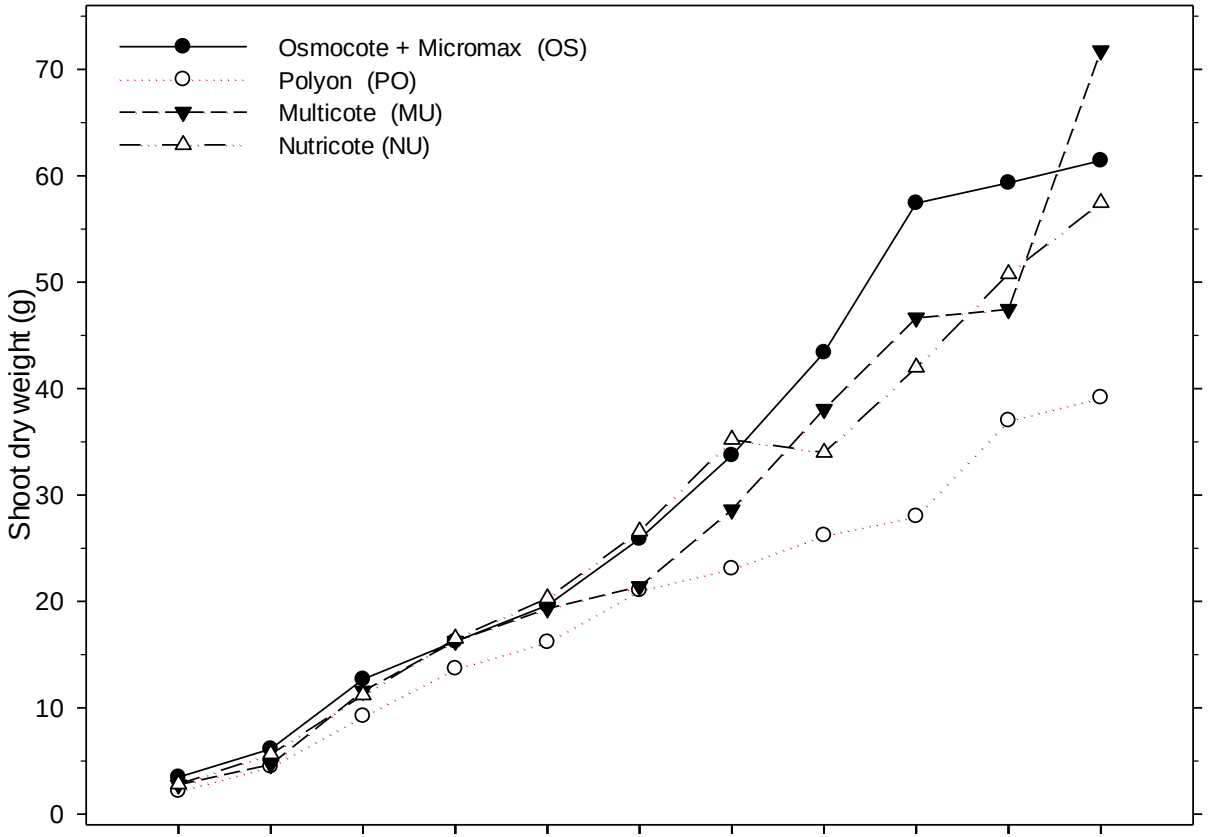
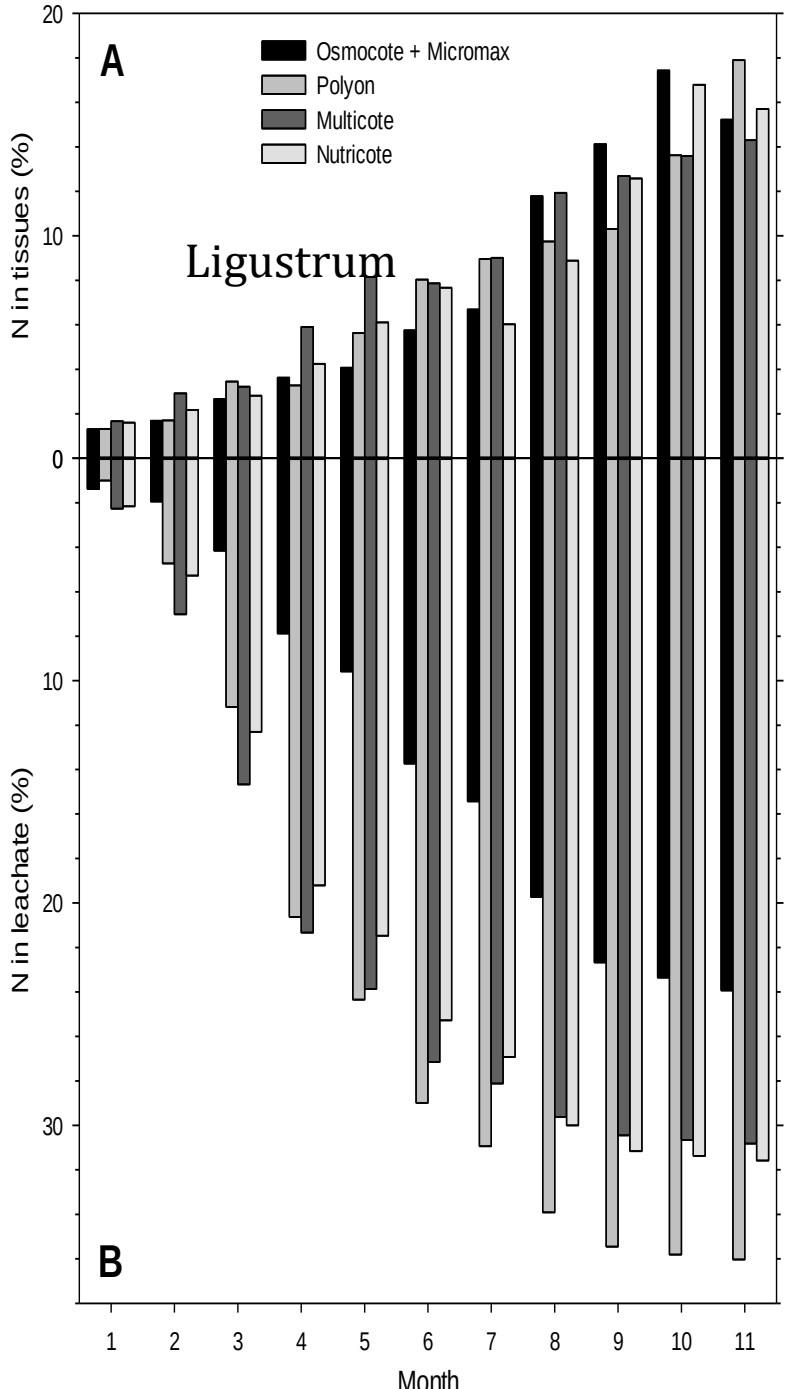
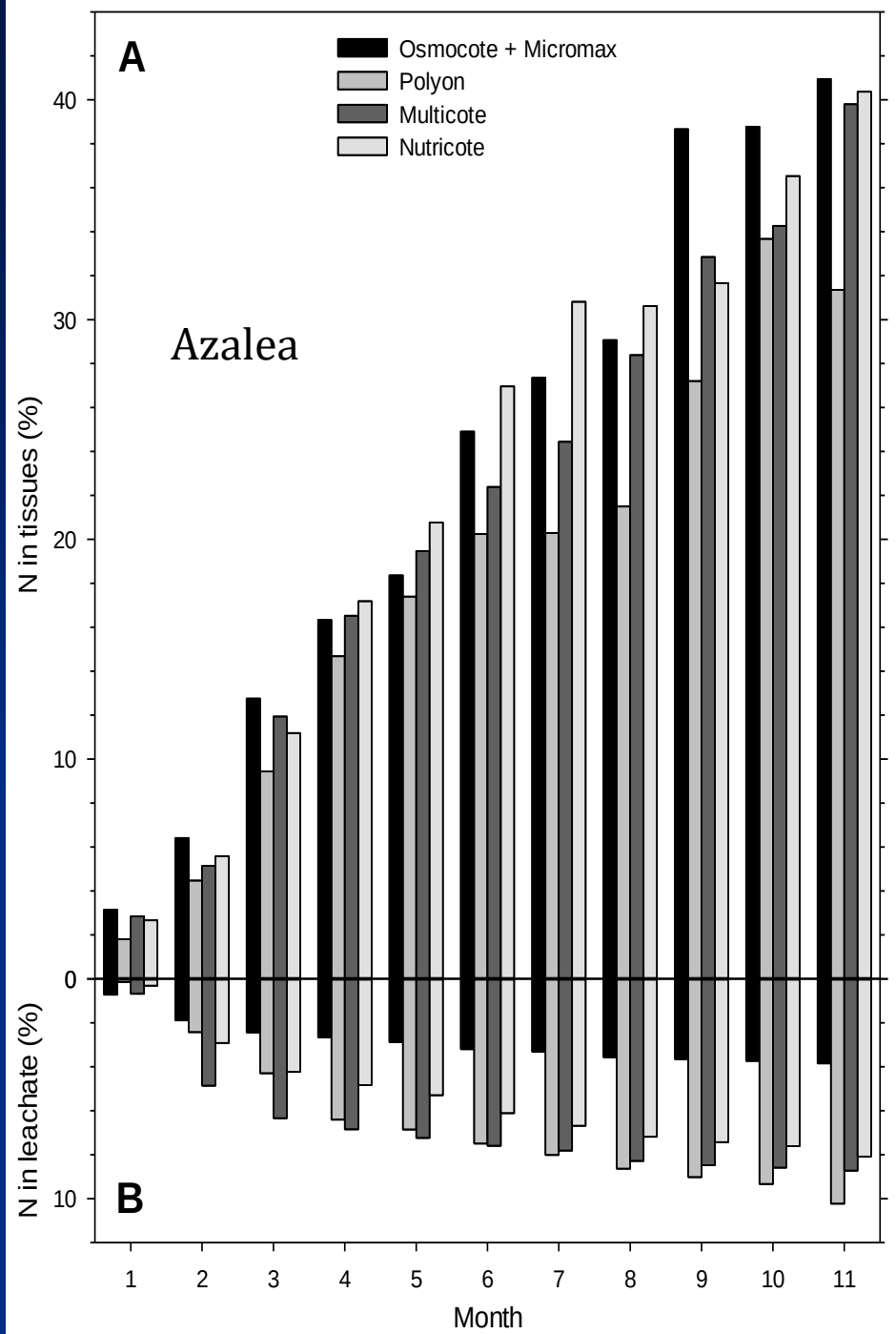


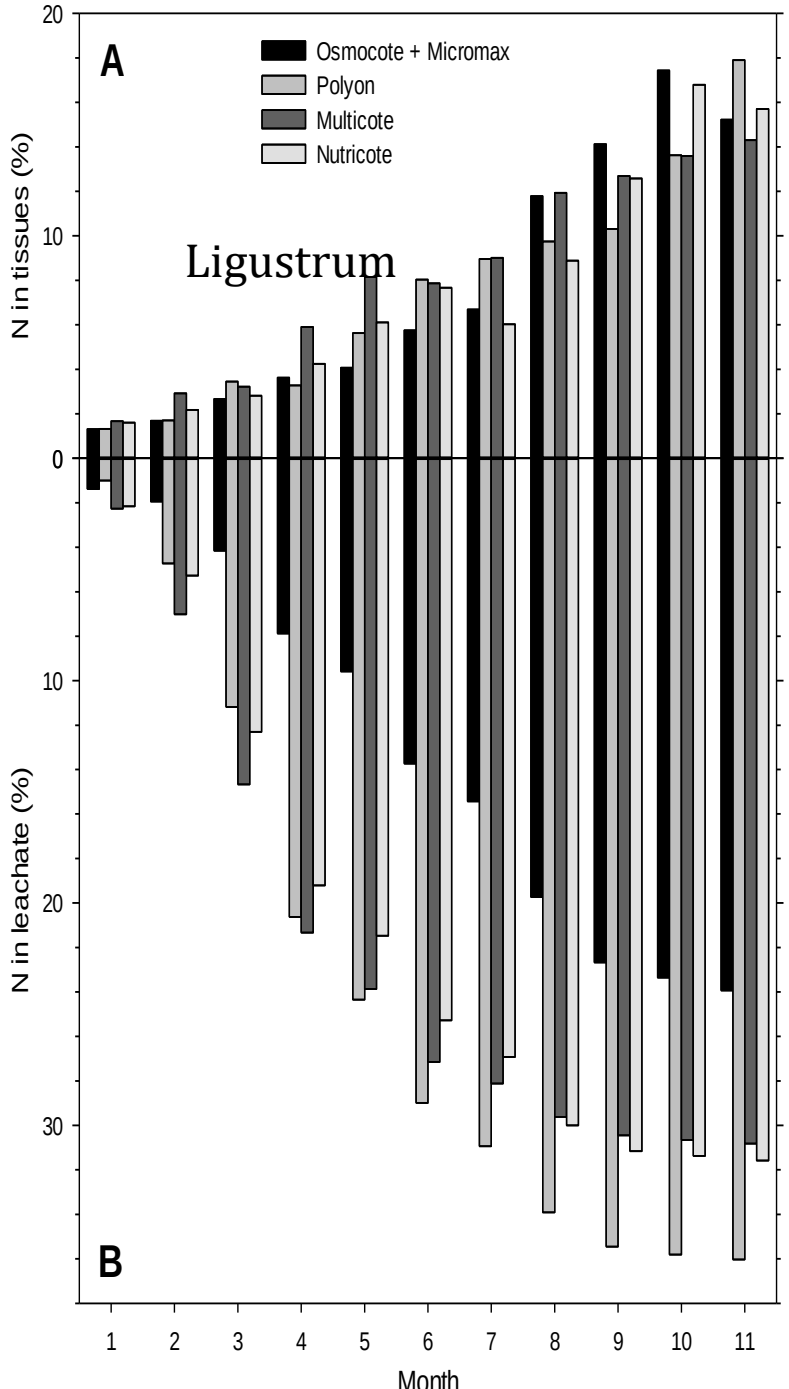
Month:	1	2	3	4	5	6	7	8	9	10	11
OS:PO	+	·	+	·	·	+	+	+	+	+	+
OS:MU	+	·	·	·	·	+	·	·	+	·	·
OS:NU	+	·	·	·	·	·	·	+	+	·	·
PO:OS	–	·	–	·	·	–	–	–	–	–	–
PO:MU	–	·	–	·	·	·	·	–	–	·	–
PO:NU	–	·	–	·	·	–	–	–	–	·	–
MU:OS	–	·	·	·	·	–	·	·	–	·	·
MU:PO	+	·	+	·	·	·	·	+	+	·	+
MU:NU	·	·	·	·	·	–	–	·	·	·	+
NU:OS	–	·	·	·	·	·	·	–	–	·	·
NU:PO	+	·	+	·	·	+	+	+	+	·	+
NU:MU	·	·	·	·	·	+	+	·	·	·	–



20% Uptake in Ligustrum

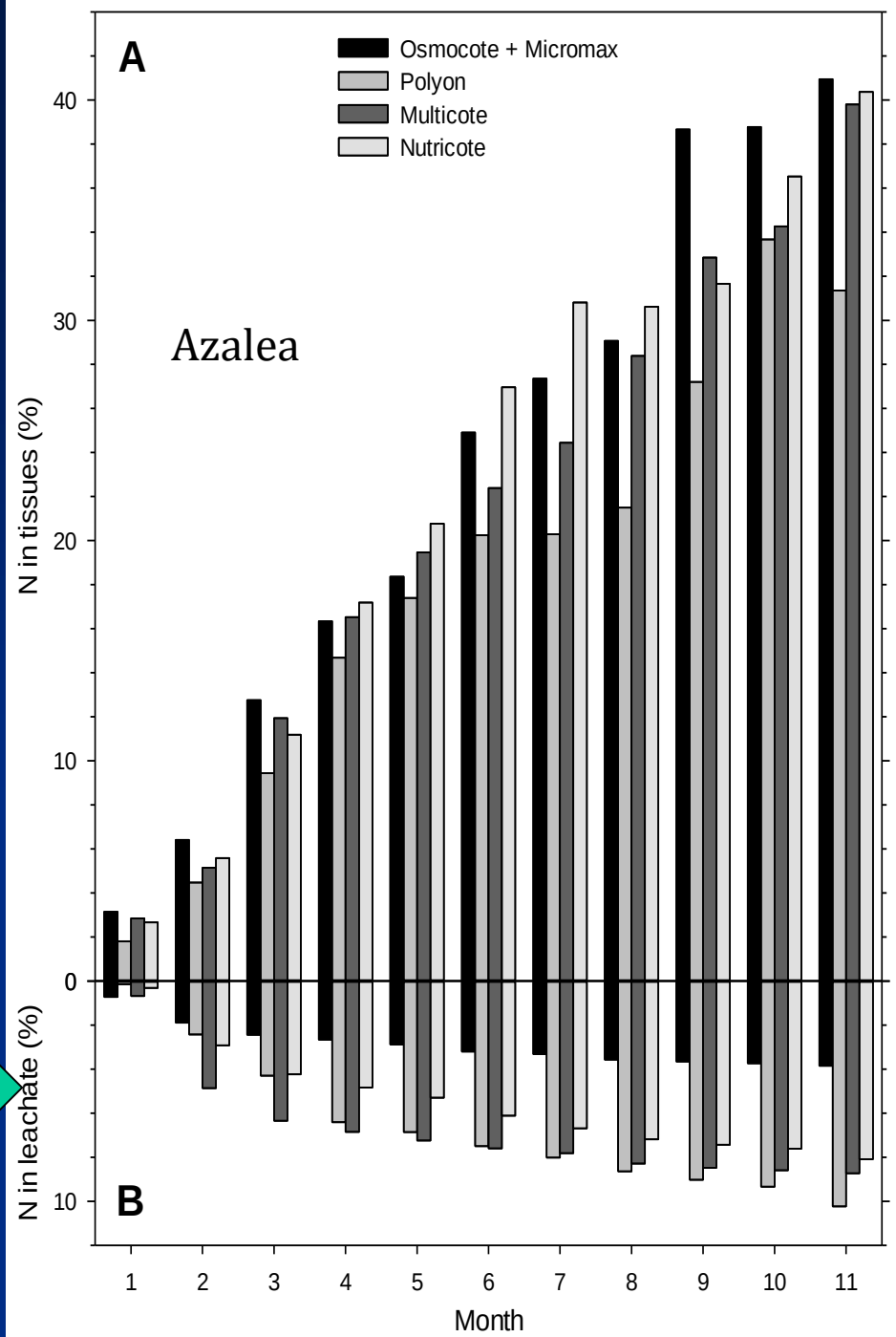
40% Uptake in Azalea





30+% Leached in Ligustrum

10% Leached in Azalea



Summary:

Fertilizer leaching greatest first two months

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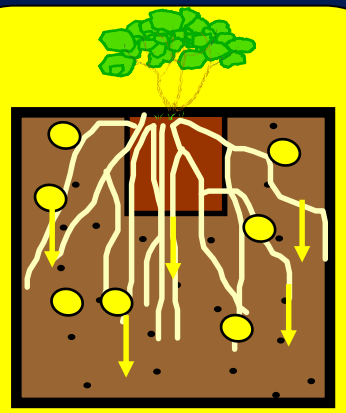
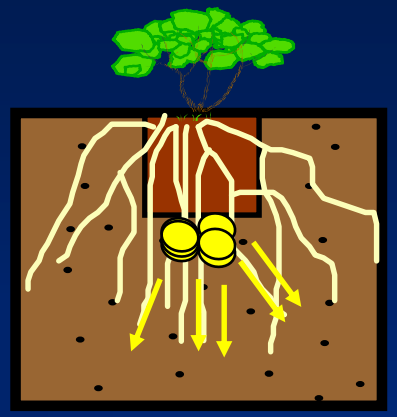
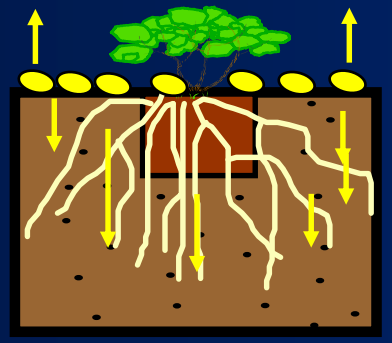
Granular Fertilizers Application Methods



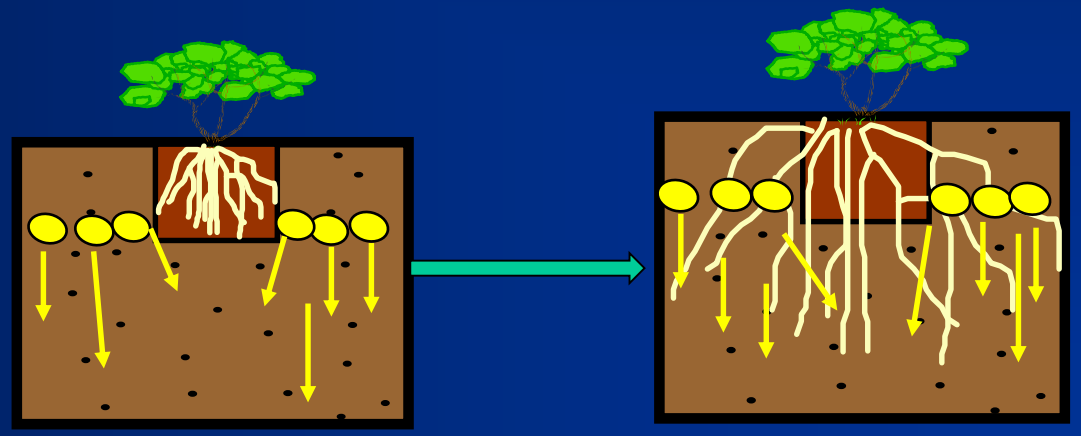
Blended



Dibble



Topical



Layered

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