Chapter 10

Foliar Nutrient Concentrations of Oak, Hickory, and Red Maple

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Abstract

Early autumn foliar nutrient concentrations of overstory oak (white oak [*Quercus alba* L.] or chestnut oak [*Q. prinus* L.]) understory hickory (mockernut hickory [*Carya tomentosa* (Poir.) Nutt.] or pignut hickory [*C. glabra* (Mill.) Sweet]), and both overstory and understory red maple (*Acer rubrum* L.) were analyzed in relation to Integrated Moisture Index (IMI) classes. Foliar nutrient concentrations varied among the three species groups, emphasizing that differential uptake and utilization of nutrients is species dependent. Concentrations in late summer were within the range reported for these species for all nutrients except nitrogen (N). Concentrations of N were below the presumed normal range for oaks and hickory, likely due to the late sampling date. Leaves were collected in late September just as autumn coloration was beginning, indicating that retranslocation was occurring. Foliar nutrient concentrations in red maple did not differ between the Watch Rock and Arch Rock study areas, between designated treatment units (control and frequent burn), or between understory and overstory trees. Differences in concentrations between IMI classes were limited to the oaks and hickories. In hickory, foliar P and Mg increased significantly from the xeric to intermediate sites. However foliar P in oak was greatest in intermediate plots and lowest in mesic plots. These limited differences in concentrations between IMI classes did not always reflect differences in A-horizon soil chemistry [TIN (total inorganic nitrogen), PO_4, Ca, Mg, Al] indicating that factors in addition to soil concentrations play a role in nutrient uptake.

Introduction

Nutrient availability is a key site component affecting the productivity of natural ecosystems. It is determined by numerous factors, including those that influence the soil's ability to supply nutrients as well as the plants' ability to utilize them (Corey and Schulte 1973; Jungk 1996). Such factors include soil physical and chemical properties, soil microorganisms, water availability, plant species, and physical and chemical properties of plant roots, including mycorrhizal infection (Corey and Schulte 1973; Grigal 1990; Bledsoe and Atkinson 1991; Chapin 1991). Foliar nutrient concentrations reflect the combined influence of these many factors, and provide a means of evaluating sites for deficiencies or monitoring potential changes due to natural and anthropogenic disturbances and management practices (Mitchell 1936; Leaf 1973).

Most of the elements essential to plant growth are assimilated through root absorption of ions from the soil solution (Jungk 1996). Thus, water availability is an important determinant of nutrient availability and can greatly affect plant growth. As soil water content decreases, transpiration is reduced and ions become less mobile (Walker 1991). This reduces nutrient availability and can occur even before reductions in soil water potential restrict water uptake for most plants (Nye and Tinker 1977). Both topographic and edaphic characteristics are important in determining the available soil moisture of a site (Fralish 1994; Meiners et al. 1984). Single indexes such as the Integrated Moisture Index (IMI) have been developed to integrate topographic and soil features of the landscape that affect moisture levels in forest ecosystems (Iverson et al. 1997; Chapter 3). The IMI classification can then be related statistically to ecological processes.

Mixed-oak forests of southern Ohio, like many other eastern forests, are becoming dominated by red maple in the understory and midstory in part because red maple exhibits growth and physiological characteristics of both early and late successional species and tends to have lower water, nutrient, and light requirements than other species (Abrams 1998). We were interested in determining how foliar nutrient concentrations varied among species exhibiting different growth characteristics within the mixed-oak forests of southern Ohio. Species typically found on all plots were selected for study and included overstory white and chestnut oak, (longlived, intermediate shade tolerance), understory pignut and mockernut hickory (sapling size, intermediate shade tolerance) and red maple (shortlived, fastgrowing, shade intolerant) (Burns and Honkala 1990). We were also interested in determining whether tree size or crown position within the canopy affects foliar nutrient concentrations. Red maple was one of the few species that was commonly found as both understory and overstory trees on these plots. Thus, the purpose of this study was: (1) characterize the foliar nutrient chemistry of overstory oak, understory hickory and overstory and understory red maple growing in southern Ohio, and (2) determine whether soil moisture and soil chemistry affect foliar nutrient chemistry.

Methods

Study Areas and Experimental Design

The study areas and experimental design are described in detail in Chapter 1. Here a brief overview is provided. The four 75-90 ha study areas are located in Vinton County (Arch Rock and Watch Rock) and Lawrence County (Young's Branch and Bluegrass Ridge). The study areas are within in the Southern Unglaciated Allegheny Plateau, which is characterized by high hills, sharp ridges, and narrow valleys. Sandstones and shales are principle bedrocks. Forests are oak-dominated and the current overstory originated in the late-1800s, after the cessation of clearcutting for the charcoal iron industry.

In each study area, three prescribed fire treatments were established, a control unit (CONT), an infrequent burn unit (INFR), and a frequent burn unit (FREQ). To account for variation in soil moisture and vegetation, a GIS-derived integrated moisture index (IMI) was applied across the dissected landscapes of the study areas (Chapter 3). From the calculated IMI scores, each 30 x 30 m pixel was assigned to one of three soil moisture classes: xeric, intermediate, or mesic. Thus to examine the effects of prescribed fire and account for environmental heterogeneity, a split-plot experimental design was established. The four study areas are replicate blocks, fire treatment units are whole plots, and IMI classes are subplots. The 50 x 25 m vegetation plots (N= 108 total) were established as pseudoreplicates in each IMI class within each fire treatment unit (Chapter 1).

Field and Laboratory Methods

On September 25-27, 1995, foliage samples were collected from randomly selected healthy understory and overstory trees from the xeric, intermediate, and some mesic plots for the Cont and Freq units at WR and AR. Leaves were collected from two dominant or codominant overstory red maples and three understory red maples within or near the plots. At WR additional foliage was sampled from two overstory oak (white or chestnut oak), and three understory hickory (mockernut or pignut hickory) in or near each plot. Overstory trees had a dbh >10 cm and understory trees had a dbh of 3-10 cm. Approximately 25 oak and red maple leaves and approximately 3 hickory leaves were collected from the outer portion of the mid to upper third of the canopy of each sampled tree using pole pruners or by shooting down the foliage. Fewer hickory leaves were collected due to the larger size of the compound leaf and the limited number of leaves per tree. The general condition of the leaves was noted at the time of collection.

Leaf samples were dried for 48 h at 70°C and ground prior to analysis. In the laboratory, total kjeldahl nitrogen (N) and total phosphorus (P) in a kjeldahl digest were determined for each tree using a Lachat Autoanalyzer (Diamond 1992). Concentrations of K, Ca, Mg, Mn, Fe, Cu, Zn, B, Al, and Na were analyzed by dry ashing the sample, dissolving the ash in nitric acid and analyzing the solution by inductively coupled plasma emission spectrophotometry (Watson 1981) at the Research Extension Analytical Laboratory at the Ohio Agricultural Research and Development Center, Wooster, OH.

Data Analysis

Overstory and understory red maple were common on all plots. However, the number and species of oaks and hickories varied from plot to plot. There were hickories on the mesic sites (Table 1). Because of this uneven tree distribution, data are presented as species groups (oaks, hickories, red maple overstory or understory) rather than as individual species.

Differences among treatment units and IMI classes were determined with a mixed model ANOVA (Littell et al. 1996) using plot means followed by single degree-of-freedom contrasts when significant differences were detected. Data from each species group were analyzed separately. Additional analyses were run to determine differences among study areas and canopy position in red maple, and to compare foliar nutrient concentrations among the three species groups. All analyses were run using SAS version 6.12 (SAS 1990).

Results

Macronutrients

Foliar nutrient concentrations of the five macronutrients differed significantly among the three species (Table 2). There were no significant differences between the overstory

Table 1. - Number of plots and total number of trees of each species[1] sampled at Watch Rock and Arch Rock study areas.

Study area	Treatment unit	IMI classification	Number of plots	Overstory RM	Overstory WO	Overstory CO	Understory RM	Understory PH	Understory MH
Watch Rock	C	Xeric	3	6	0	6	9	6	3
		Intermediate	2	4	4	0	6	4	0
		Mesic	1	2	0	2	3	0	0
	F	Xeric	2	4	0	4	6	1	5
		Intermediate	4	8	5	3	12	4	8
		Mesic	0	0	0	0	0	0	0
Arch Rock[2]	C	Xeric	3	6	—	—	9	—	—
		Intermediate	1	2	—	—	3	—	—
		Mesic	2	4	—	—	6	—	—
	F	Xeric	4	8	—	—	12	—	—
		Intermediate	2	4	—	—	6	—	—
		Mesic	0	0	—	—	0	—	—

[1]RM=red maple, WO=white oak, CO=chestnut oak, PH=pignut hickory, MH=mockernut hickory.
[2]Only overstory and understory red maple were sampled at Arch Rock

and understory red maple, so the maple data were combined for this analysis. Foliar N and P were significantly greater in the oaks compared to both the hickories and red maple, which exhibited similar concentrations. Oak and hickory had similar concentrations of K, which in turn were significantly greater than those of red maple. Levels of Ca and Mg were greatest in hickory while those in maple and oak were similar.

Concentrations of N, K, Ca, and Mg oak foliage did not differ significantly between the Cont and Freq units or among IMI classes (Appendix). However, P was significantly higher in the Cont unit, and intermediate IMI plots had greater concentrations of P than the xeric or mesic plots. For hickory, P and Mg were greatest in the intermediate plots (Appendix). A significant treatment-by-IMI class interaction was present such that foliar P was considerably lower in hickories from the Freq unit than from the Cont unit on the xeric plots, yet there were no differences between treatment units (Appendix).

Red maple growing at WR and AR had similar foliar macronutrient concentrations; there were no significant differences in nutrient concentrations due to designated treatment unit or IMI class. (Appendix). Likewise, crown position had no apparent effect on macronutrient concentrations of red maple. (Appendix).

Trace Elements

Trace Element concentrations tended to be higher in hickory foliage than in oak or red maple foliage except for Cu, which was highest in maple (Appendix). Although the magnitude of differences in foliar concentrations between species was generally zero to fivefold, concentrations of Al were 80 to 150 times higher in hickory, than in oak or red oak.

Foliar concentrations of the trace elements in oaks and hickories differed between treatment units and among IMI classes. Significant differences due to treatment unit, IMI or their interactions were detected in the oaks for Mn, Fe, Cu, Zn, and Na. (Appendix). Interactions generally resulted from a difference in the direction of the response to soil moisture in the Cont and Freq units. Hickory also showed differences in Mn and B concentrations. There were differences in concentrations of trace elements in red maple between treatment units or among IMI classes. (Appendix). However, there were differences in these concentrations in overstory red maple foliage between study areas. Overstory red maple at WR had higher concentrations of Mn ($p = 0.0165$), Fe ($p = 0.0030$), Zn ($p = 0.0130$), and Al ($p = 0.0001$), and lower concentrations of Na (0.0046) than at AR. Similar differences were not present in the understory red maple.

Discussion

Late summer foliar nutrient concentrations of P, K, Ca, and Mg in oak were within the range reported for white and chestnut oak, but N concentrations tended to be lower than values reported in other studies (Mitchell 1936; Leaf 1973; Boerner 1984; Jones et al. 1991). Limited data were available for hickory, but N values were below those reported for mockernut hickory (Abrams and Mostoller 1995) and hickory species in general (Kaczmarek et al. 1998; Martin et

Table 2. - Analysis of Variance probabilities of significant differences due to treatment unit, IMI class and their interaction.

Species/Source	Numer-ator d.f.	Denom-inator d.f.	Macronutrient p-values N	P	K	Ca	Mg
Overstory Oak[1]							
Treatment unit	1	7	0.1177	0.0169	0.3477	0.5160	0.9900
IMI class	2	7	0.5469	0.0429	0.3213	0.5609	0.5302
Treatment*IMI	1	7	0.9734	0.1095	0.8786	0.0765	0.9253
Understory Hickory[1]							
Treatment unit	1	7	0.6053	0.1536	0.0553	0.1070	0.2175
IMI class	1	7	0.0940	0.0311	0.4520	0.5247	0.0134
Treatment*IMI	1	7	0.1967	0.0448	0.4300	0.3464	0.6175
Overstory Red Maple[2]							
Treatment unit	1	1	0.9023	0.4247	0.7068	0.4431	0.6544
IMI class	2	3	0.2728	0.6205	0.1011	0.2942	0.6086
Treatment*IMI	1	3	0.3320	0.3158	0.2283	0.0848	0.0451
Understory Red Maple[2]							
Treatment unit	1	1	0.4234	0.5152	0.5961	0.5485	0.8291
IMI class	2	3	0.1487	0.5986	0.6527	0.5941	0.8766
Treatment*IMI	1	3	0.5322	0.2639	0.8848	0.2867	0.9838

[1] Analysis includes trees from Watch Rock study area only.

[2] Analysis includes trees from Watch Rock and Arch Rock study areas.

al. 1998). Macronutrients in both overstory and understory red maple were within the ranges reported for this species (Mitchell 1936; Boerner 1984; Jones et al. 1991; Abrams 1998). Trace element concentrations for all species fell within the ranges reported by Leaf (1973) for forest trees.

The low concentrations of N in oak and hickory foliage might have been related to sampling time. Since concentrations can vary considerably throughout a growing season, the timing of sampling is critical. Deciduous foliage should be sampled after full leaf expansion but before appreciable redistribution of nutrients in late summer or autumn (Walker 1991). The retranslocation of nutrients from deciduous foliage to stems occurs 3 to 4 weeks prior to leaf abscission (van den Driessch 1984). Our samples were collected just as leaf coloration was visible beginning in some trees though only green leaves were collected for analyses. However, translocation of mobile nutrients (N, P, K, Mg) was most likely occurring, resulting in foliar concentrations lower than expected. Alternatively, foliar nitrogen may have reflected low soil nutrient availability on these acidic soils though this seems unlikely since soil data suggest that these sites are becoming N-enriched and may no longer be nitrogen limited (Chapter 5). Soil Ca/Al (mole/mole) ratios below 1.0 were common at AR and WR, particularly in xeric plots (Chapter 5). This suggests the possible increased risk of adverse impacts on tree growth and nutrition due to Al stress and greater nutrient imbalances (Cronan and Grigal 1995).

Inherent differences among species play an important role in the absorption and utilization of mineral nutrients from the soil (Goddard and Hollis 1984). This can result in differences in foliar nutrient concentrations and in the allocation of minerals within a tree. As expected, oak, hickory, and red maple growing in close proximity demonstrated differences in foliar nutrient concentrations. Lower concentrations of N, P, and K in red maple relative to oak in mixed oak forests have been reported (Mitchell 1936; Boerner 1984; Martin et al. 1998). Red maple generally has lower nutrient requirements than many tree species in the Eastern United States (Abrams 1998).

Tree size and crown class can affect the anatomy, morphology, and ecophysiology of leaves within a forest canopy due to the uneven distribution of light (Leaf 1973). For example, leaves grown at low irradiance generally are thinner and have a lower leaf mass per area and N content than those grown at high irradiance (Abrams and Kubiske 1990; Abrams and Mostoller 1995). They also tend to have more chlorophyll on a leaf-weight basis, thus increasing light harvesting pigments as a way to maximize net CO_2 fixation at low irradiance (Boardman 1977). These changes can alter the partitioning of nutrients within the leaves. We found no significant differences in foliar nutrient concentrations (mg N g^{-1}) between overstory and understory red maple. Similarly, Abrams and Mostoller (1995) found no differences in N concentrations between open-grown and understory trees of six deciduous species, including red maple. They did find that the N content (g N m^{-2}) was significantly greater in open-grown plants for most species, and suggested that this reflects differential N partitioning. We will consider leaf concentrations and content in subsequent collections.

The A-horizon soils at AR and WR had similar chemical properties except for NH_4 and TIN (total inorganic nitrogen), which were both significantly greater at WR (Chapter 5). However, foliar N in overstory and understory trees was similar at both study areas and did not reflect this difference in soil nitrogen. Trace nutrients other than Al were not tested in the soils. Concentrations of trace elements in foliage from overstory red maple grown at AR differed significantly from those at WR, suggesting that actual soil concentrations or conditions that affect uptake differed at the two study areas.

Differences in foliar nutrient concentrations among xeric, intermediate, and mesic plots were limited to P in oak and hickory and Mg in hickory. This was surprising since water availability is an important factor in nutrient uptake (Jungk 1996) and there were significant differences in chemical properties of A-horizon soils among IMI classes. Soil concentrations of TIN, PO_4, Ca, and Mg generally were significantly lower in xeric than in intermediate and mesic plots, which did not differ significantly from each other (Chapter 5). By contrast Al decreased with increasing soil moisture. Foliar N, Ca, and Al did not show this same pattern for any tree species, but P in oak and hickory and Mg in hickory did increase from xeric to intermediate plots, demonstrating how soil chemistry is not always a good predictor of foliar chemistry. The decrease in P at mesic sites did not follow this pattern, but only one mesic plot was sampled and this may not reflect the general trend. Precipitation was not limiting during the spring and early summer when leaves were expanding, suggesting that sufficient moisture was available in the plots of all three IMI classes, and that initial nutrient uptake was not affected greatly on any of the plots. Variations in foliar nutrient levels may be more apparent during drier years when differences in soil moisture availability are more pronounced among xeric, intermediate, and mesic plots.

Our data provides a baseline for monitoring seasonal and yearly changes in foliar nutrient concentrations of oaks, hickory and red maple in southern Ohio, and in investigating the relationship between foliar and soil chemistry, and site conditions. Foliar nutrient dynamics will continue to be monitored to assess the short- and long-term effects of prescribed fire.

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Appendix — Trace element concentrations (mean+1 se) in foliar tissue collected in September 1995. Probabilities for differences due to treatment unit, IMI class, and treatment*IMI class interactions are presented.

		Trace Element (mg kg^{-1})						
Treatment/ IMI class	# plots	Mn	Fe	B	Cu	Zn	Al	Na
Overstory Oak								
Treatment C								
Xeric	3	880.7	48.16	50.96	5.89	15.66	74.83	12.22
		(3.6)	(3.27)	(4.39)	(0.20)	(0.67)	(1.15)	(0.76)
Intermediate	2	777.9	53.29	47.14	6.06	15.21	80.24	7.92
		(106.0)	(6.93)	(3.40)	(0.67)	(3.16)	(13.15)	(0.18)
Mesic	1	719.7	48.23	57.75	5.48	15.35	64.78	10.23
Treatment F								
Xeric	2	563.1	57.67	57.55	4.51	11.67	78.9	7.75
		(47.0)	(4.05)	(2.98)	(0.12)	(0.93)	(4.04)	(1.12)
Intermediate	4	658.0	48.24	54.24	5.80	12.77	69.66	11.97
		(28.8)	(1.39)	(5.69)	(0.16)	(0.94)	(1.90)	(1.65)
Overall Mean	12	716	50.68	53.50	5.60	13.80	73.89	10.38
		(28.1)	(1.55)	(1.95)	(0.15)	(0.56)	(2.14)	(0.61)
Source		Analysis of Variance Probabilities						
Treatment Unit		0.0004	0.4304	0.1503	0.0073	0.0202	0.4159	0.8599
IMI Class		0.2608	0.6300	0.4193	0.0294	0.9553	0.1958	0.9962
Treatment*IMI		0.0253	0.0295	0.9533	0.0384	0.4968	0.0930	0.0069
Understory Hickory								
Treatment C								
Xeric	3	654.9	65.92	68.05	6.70	99.10	5341	11.93
		(39.0)	(4.51)	(3.38)	(0.27)	(10.34)	(636)	(1.18)
Intermediate	2	632.5	62.94	64.45	7.26	94.42	7551	11.14
		(16.6)	(8.77)	(0.44)	(0.60)	(16.42)	(1517)	(1.76)
Treatment F								
Xeric	2	544.0	59.13	75.6	6.51	105.96	4723	10.73
		(25.0)	(1.85)	(0.27)	(0.30)	(7.44)	(385)	(0.28)
Intermediate	4	771.8	66.30	72.08	7.49	92.16	6055	11.74
		(42.2)	(1.18)	(1.86)	(0.58)	(10.02)	(996)	(0.75)
Overall Mean	12	678.8	64.13	71.01	7.05	96.86	5836	11.47
		(31.8)	(1.86)	(1.89)	(0.21)	(4.62)	(402)	(0.40)
Source		Analysis of Variance Probabilities						
Treatment Unit		0.6887	0.6167	0.0066	0.9744	0.8152	0.2443	0.7384
IMI Class		0.0196	0.5429	0.1155	0.1231	0.3621	0.0707	0.9052
Treatment*IMI		0.0079	0.1655	0.9919	0.6522	0.6455	0.6144	0.3388

Treatment/ IMI class	# plots	Trace Element (mg kg^{-1}) Mn	Fe	B	Cu	Zn	Al	Na
Overstory Red Maple								
		Watch Rock Study Site						
Treatment C								
Xeric	3	802.2	44.58	36.71	9.60	27.58	50.57	6.44
		(44.3)	(2.07)	(0.58)	(1.09)	(1.40)	(7.91)	(1.33)
Intermediate	2	734.0	49.71	38.77	10.57	29.87	50.45	6.40
		(7.2)	(2.93)	(4.03)	(0.74)	(4.10)	(17.08)	(0.37)
Mesic	1	760.6	53.08	38.54	12.35	24.68	54.23	3.76
Treatment F								
Xeric	2	475.7	49.88	45.40	6.83	21.05	56.31	5.34
		(31.3)	(1.44)	(8.86)	(1.14)	(3.96)	(8.97)	(0.27)
Intermediate	4	620.2	41.24	40.44	8.59	19.96	49.24	8.47
		(56.6)	(2.06)	(3.90)	(0.61)	(0.81)	(3.48)	(1.24)
		Arch Rock Study Area						
Treatment C								
Xeric	3	566.2	39.02	36.85	9.31	17.65	41.68	7.43
		(60.8)	(3.44)	(2.66)	(1.53)	(2.61)	(2.18)	(1.03)
Intermediate	1	520.6	29.06	40.66	8.02	17.46	21.66	7.36
Mesic	2	489.2	32.56	36.35	10.54	17.16	32.30	8.92
		(42.4)	(0.24)	(1.29)	(0.18)	(1.09)	(1.67)	(0.16)
Treatment F								
Xeric	4	639.2	55.38	39.43	9.53	21.85	38.44	8.23
		(29.35)	(6.05)	(2.08)	(0.79)	(1.82)	(2.48)	(1.13)
Intermediate	2	683.8	35.16	40.50	8.50	27.32	28.68	9.96
		(22.0)	(5.40)	(1.74)	(0.92)	(0.77)	(0.84)	(1.50)
Overall Mean	24	632.9	43.92	39.22	9.27	22.32	43.29	7.53
		(19.37)	(1.58)	(0.95)	(0.34)	(0.84)	(1.96)	(0.41)

Source	Analysis of Variance Probabilities						
Treatment Unit	0.7297	0.4860	0.4106	0.3882	0.7684	0.7994	0.3815
IMI Class	0.6906	0.2006	0.8985	0.4105	0.4284	0.2896	0.4682
Treatment*IMI	0.1090	0.1081	0.4646	0.8244	0.9186	0.9498	0.2638

Treatment/ IMI class	# plots	Trace Element (mg kg^{-1}) Mn	Fe	B	Cu	Zn	Al	Na
Understory Red Maple								
				Watch Rock Study Site				
Treatment C								
Xeric	3	741.5	44.76	36.68	6.61	20.46	41.52	5.41
		(40.)	(4.24)	(2.12)	(0.42)	(2.96)	(5.36)	(0.76)
Intermediate	2	723.6	40.02	31.74	8.13	28.87	35.97	8.01
		(52.3)	(2.77)	(2.70)	(0.48)	(2.32)	(12.29)	(2.29)
Mesic	1	646.5	45.19	35.49	8.05	33.23	26.54	7.48
Treatment F								
Xeric	2	518.1	44.50	37.88	6.51	21.5	43.92	4.78
		(9.2)	(5.88)	(1.55)	(1.60)	(1.15)	(4.16)	(1.34)
Intermediate	4	657.7	40.39	30.76	6.46	23.52	35.84	6.25
		(71.3)	(2.46)	(1.13)	(0.71)	(1.81)	(0.92)	(0.71)
				Arch Rock Study Area				
Treatment C								
Xeric	3	551.9	37.36	37.20	7.87	18.42	36.44	9.18
		(38.04)	(1.69)	(6.59)	(0.16)	(2.47)	(1.13)	(1.83)
Intermediate	1	532.1	28.40	31.55	6.90	14.12	27.14	8.82
		(-)	(-)	(-)	(-)	(-)	(-)	(-)
Mesic	2	485.8	35.11	35.16	7.90	17.56	29.74	6.58
		(57.0)	(0.06)	(1.75)	(0.42)	(2.00)	(1.50)	(0.67)
Treatment F								
Xeric	4	655.0	63.04	33.20	8.43	26.52	47.10	10.25
		(50.3)	(13.00)	(2.82)	(0.76)	(3.47)	(10.40)	(0.99)
Intermediate	2	647.4	46.10	39.66	8.38	28.10	31.53	9.92
		(73.5)	(11.70)	(2.51)	(1.22)	(3.60)	(3.17)	(1.46)
Overall Mean	24	622.0	44.34	34.64	7.52	23.41	37.64	7.76
		(16.6)	(1.87)	(0.88)	(0.22)	(0.90)	(1.94)	(0.37)

Source	Analysis of Variance Probabilities						
Treatment Unit	0.9049	0.2921	0.9830	0.9132	0.4766	0.4950	0.9560
IMI Class	0.4567	0.3257	0.4819	0.9023	0.4579	0.1720	0.4929
Treatment*IMI	0.4561	0.4415	0.4258	0.4111	0.6184	0.5429	0.4879