Response of potatoes (cv. Russet Burbank) to supplemental calcium applications: Tuber yield, internal quality and tuber calcium concentration

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In the 1997 and 1998 season we evaluated the response of potatoes (cv. Russet Burbank to supplemental calcium application by using three soluble products: calcium nitrate, calcium chloride and N-Plus. In addition we also evaluated these products in combination with calsol. A combination of urea, calcium chloride and calcium nitrate was also evaluated. In 1997 we analyzed yield, internal quality and calcium contents of individual tubers. In 1998 yield and internal quality data have been analyzed but tuber calcium contents data are not yet available.

Experimental Plan

Each plot consisted of two 15 foot rows in 1997 and two 30 foot rows in 1998 and plots were separated by guard rows. All seed pieces were hand planted. Starter fertilizer (6-20-19) pretreated with admire was applied at rate of 500 lbs/acre. At emergence 224 lbs/acre ammonium nitrate (33.5-0-0) was given. Total nitrogen given 228 lbs/acre to all treatments. The balance of 128 lbs of nitrogen was split equally into four application starting at hilling, using combinations of calcium nitrate, N-Plus, ammonium nitrate, calcium chloride+urea+calcium nitrate, calcium nitrate+liquid nitrogen. The details on treatments and nutrient application are given in Table 1.

Tubers were harvested in both years at maturity and held at about 40F until they were analyzed and sampled for calcium six to eight weeks later. For defect analysis tubers were cut in half along longitudinal axis and visually inspected for defects. Eighty tubers were cut for this purpose in 1997 and 100 tubers evaluated in 1998. For calcium analyses in 1997 a longitudinal slice of about 0.25 inch was taken from tuber for calcium analysis. **A total of 75 tubers per treatment (15 per replication) were processed for calcium analyses individually.**

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Result and Discussion

In general there were no significant differences in total tuber yield among different treatments (Table 2). Overall 1997 was a good season for potato production in central Wisconsin. We generally do not see treatment effects on tuber yield under good (ideal) growing conditions since calcium is expected to have more influence on tuber yield under less than ideal (heat stress etc.) conditions. However it is interesting to note that some treatments containing calcium nitrate and/or N-Plus tended to produce slightly higher total tuber yield (Table 2).

In 1997 application of calcium as calcium nitrate and N-Plus dramatically improved tuber calcium level (Figure 3 and 4). This effect was seen both in the presence and absence of calsol. For example in ammonium nitrate treatment nearly 70% of tubers had calcium contents less than 150 ug/g dry weight (Figure 4). Furthermore there were less than 5% of tuber in ammonium nitrate treatment that had calcium level greater than 200 ug/g dry weight. Whereas in the N-Plus and calcium nitrate treatments more than 50% of the tubers had calcium greater than 200 ug/g dry weight (Figure 4). Calsol was effective in raising tuber calcium level only in non split ammonium nitrate treatment (compare figure 3 and 4). The tuber calcium level was dramatically improved by calcium nitrate and N-Plus application and concomitant there was a reduction in hollow heart and brown center defects in the tubers by these treatments as compared to ammonium nitrate treatment (Table 3). Please refer to Table 3 as some treatments demonstrated trends while other treatment differences were statistically significant.

In 1998 season unfortunately we had heavy infestation by the Colorado potato beetles. In addition several plots were effected by the verticillium wilt. These problems resulted in large variability (up to 2 fold) in tuber production in different replications with in a treatment. Thus our yield data are not very meaningful and not reported here. We did rate these tubers for defects and sampled them for calcium analyses. In general the incidence of hollow heart and internal brown spots (IBS) was quite low in all the treatments in 1998 (Table 4). We did not find any differences among treatments for these defects as the incidence overall was very low. Data on calcium are not available at this time. We plan to continue these studies in 1999.

Table 1: Nutrient application schedule 1997 and 1998.

Application of Nutrients Treatment	Source	Amount (lbs/acre) Nitrogen	Calcium	Application Timing[1]	Total Number of Applications
1997 and 1998					
Nonsplit Nitrogen	NH_4NO_3	123	0	H	1
Split Nitrogen	$NH4NO_3$	30.75	0	H, H+2, H+4, H+6	4
CalciumNit+	$Ca(NO_3)_2$	30.75	37.5	H	1
N-plus	N-Plus	30.75	15.3	H+2, H+4, H+6	3
N-plus	N-Plus	30.75	15.3	H, H+2, H+4, H+6	4
Urea+	Urea	15.37	0	H, H+2, H+4, H+6	4
$CaCl_2$+CalNit	$CaCl_2$	0	37.5	H, H+2, H+4, H+6	4
	$Ca(NO_3)_2$	15.37	18.8	H, H+2, H+4, H+6	4
$CaNO_3$	$Ca(NO_3)_2$	30.75	37.5	H, H+2, H+4, H+6	4
1998 (Additional Treatments Tested)					
$CaCl_2$+Urea	$CaCl_2$	0	15	H, H+2, H+4, H+6	4
	Urea	30.75	0	H, H+2, H+4, H+6	4
$CaCl_2$+Urea	$CaCl_2$	0	20.6	H, H+2, H+4, H+6	4
	Urea	30.75	0	H, H+2, H+4, H+6	4
UAN	Liquid N	30.75	0	H, H+2, H+4, H+6	4
UCAN	Liquid N	18.5	0	H, H+2, H+4, H+6	4
	$Ca(NO_3)_2$	12.3	15	H, H+2, H+4, H+6	4
UCAN	Liquid N	13.8	0	H, H+2, H+4, H+6	4
	$Ca(NO_3)_2$	16.9	20.6	H, H+2, H+4, H+6	4

Note: All treatments received equal amount of total nitrogen which was 228 lbs/acre
[1]H: Hilling; H+2-6: number of week after hilling.

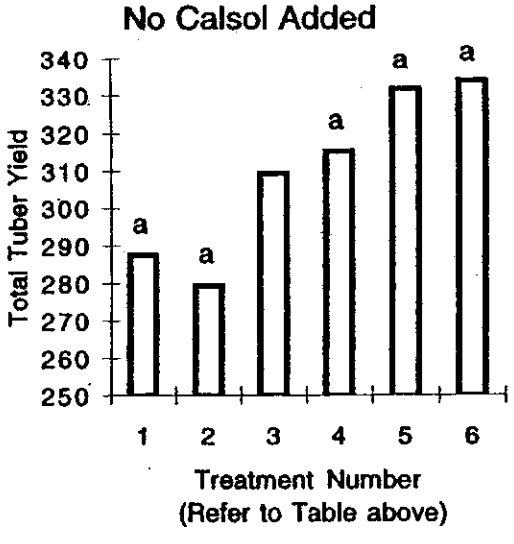
Table 2:1997 Total Yield and Yield of US #1 grade tubers by nutrient treatment.

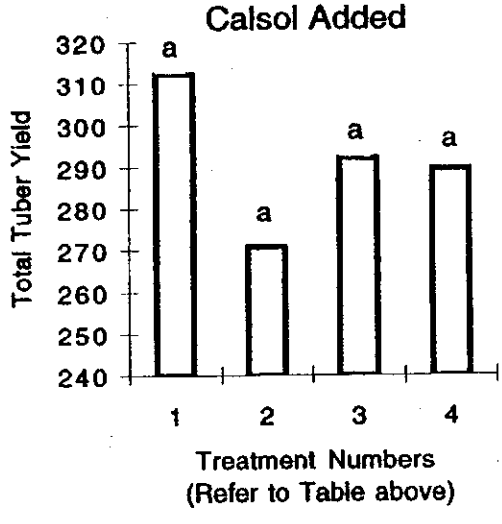
Treatment	No Calsol		Calsol Added	
	Total Yield	US #1 Yield	Total Yield	US #1 Yield
1 Non Split Nitrogen	287.5a	195.1a		
2 Split Nitrogen	279.3a	181.1a	312.2a	228.1a
3* Split Urea + $CaCl_2$ + Cal Nit	309.3	227.5		
4 Split Calcium Nitrate	315.1a	218.6a	270.6a	173.1b
5 Split Calcium Nitrate + N-Plus	331.6a	230.1a	291.9a	198.3ab
6 Split N-Plus	333.8a	235.0a	289.4a	189.6ab

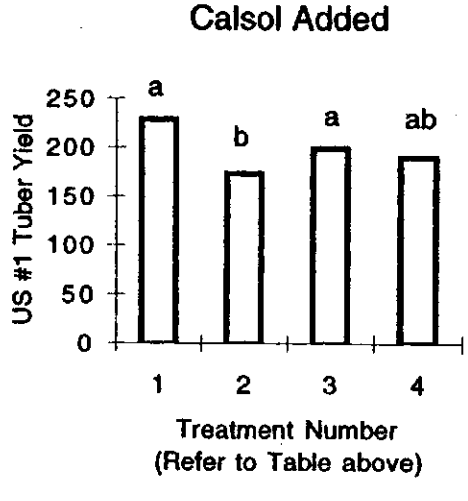
LSD (α=0.1)

*This treatment was not part of this experiment. Therefore is not included in the statistical analysis.

Figure 1: 1997 Total Yield and Yield of US #1 grade tubers by nutrient treatment (Table 2 data in graphic form).







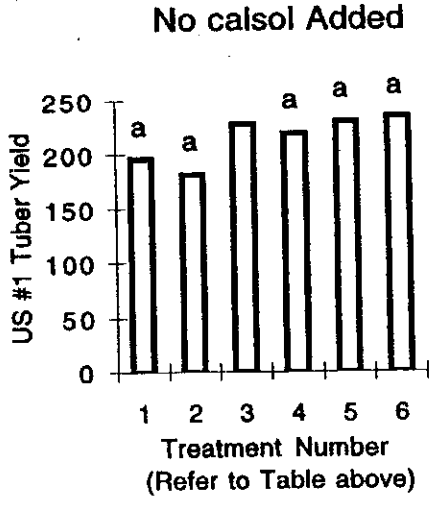


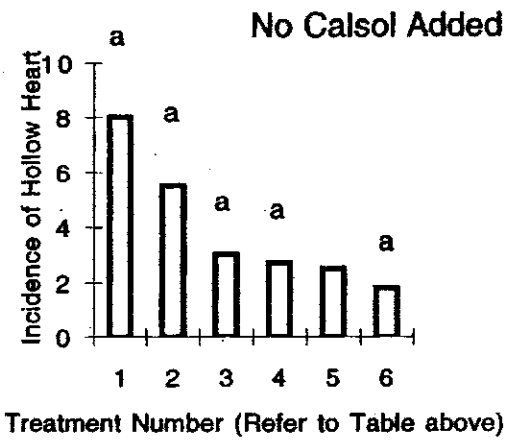
Table 3:1997 Tuber defects, hollow heart and brown center, by nutrient treatment.

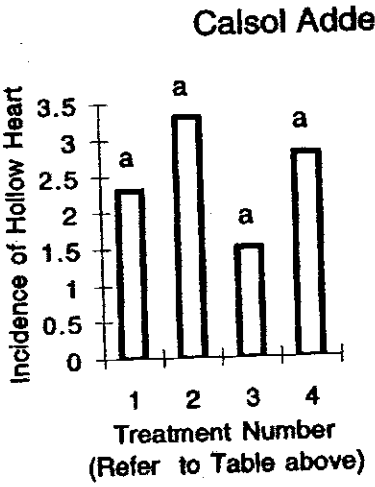
Treatment Center	No Calsol		Calsol Added	
	Hollow Heart	Brown Center	Hollow Heart	Brown
1 Non Split Nitrogen	8.0a	10.0a		
2 Split Calcium Nitrate + N-Plus	5.5a	6.3ab	2.3a	2.5a
3 Split Nitrogen	3.0a	3.6ab	3.3a	3.8a
4 Split N-Plus	2.7a	3.5ab	1.5a	2.5a
5* Split Urea + $CaCl_2$ + Cal Nit	2.5	3.8		
6 Split Calcium Nitrate	1.8a	2.8b	2.8a	3.3a

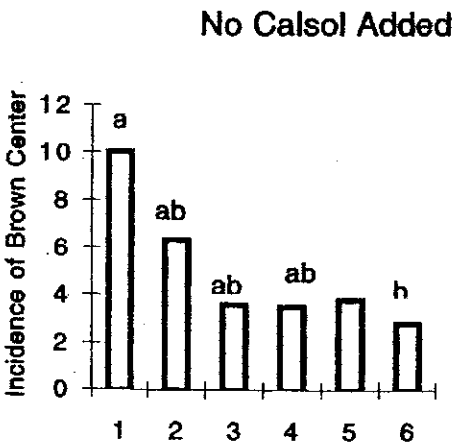
LSD (α=0.1)

*This treatment was not part of this experiment. Therefore is not included in the statistical analysis.

Figure 2: 1997 Tuber defects, hollow heart and brown center, by nutrient treatment (Table 3 data in graphic form).







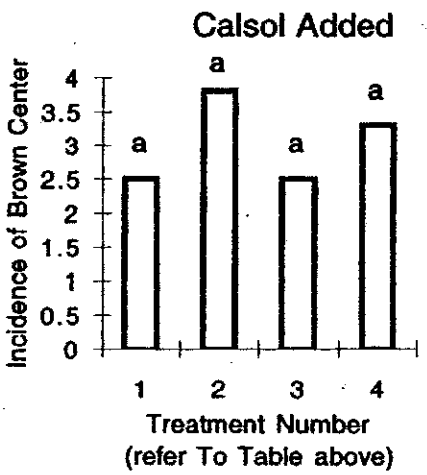
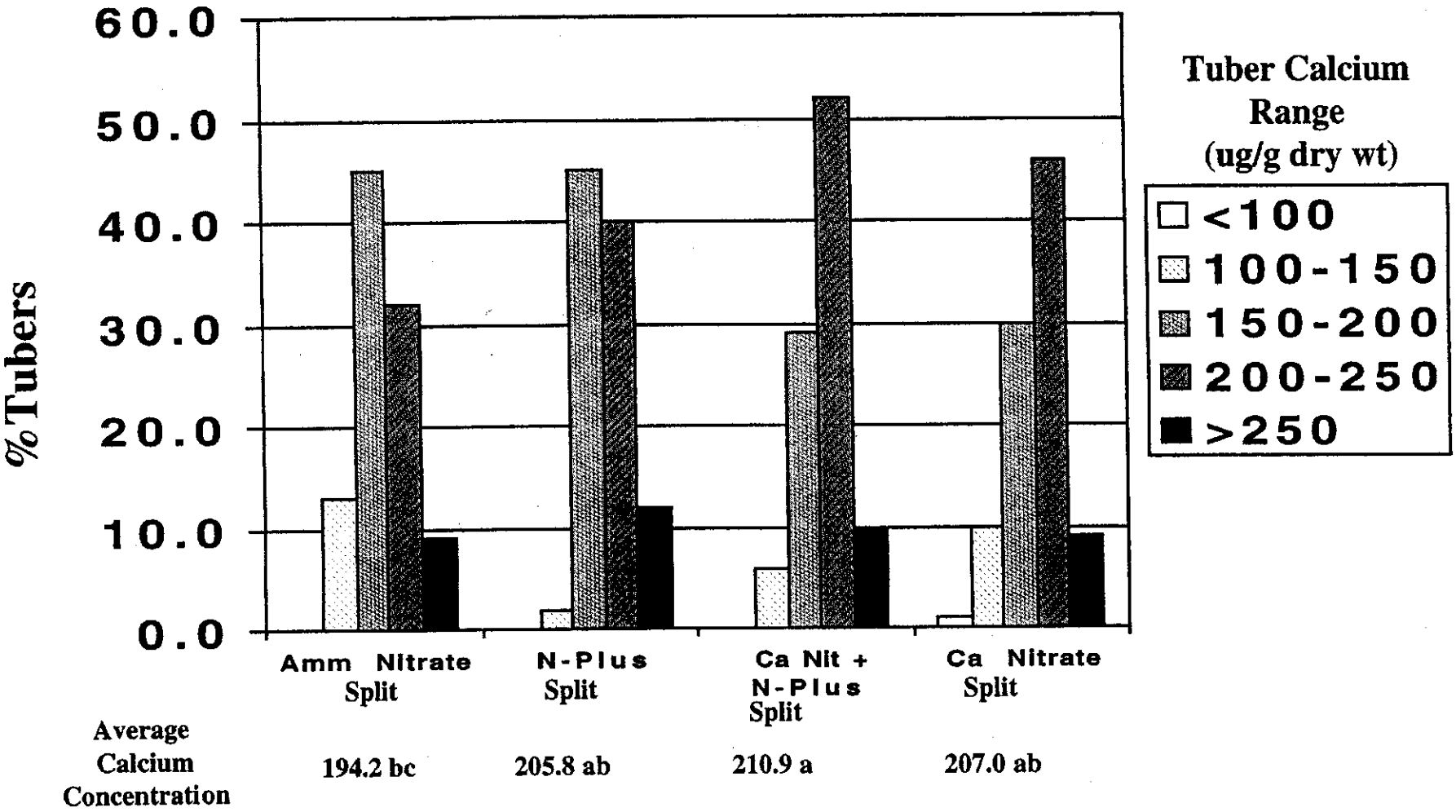


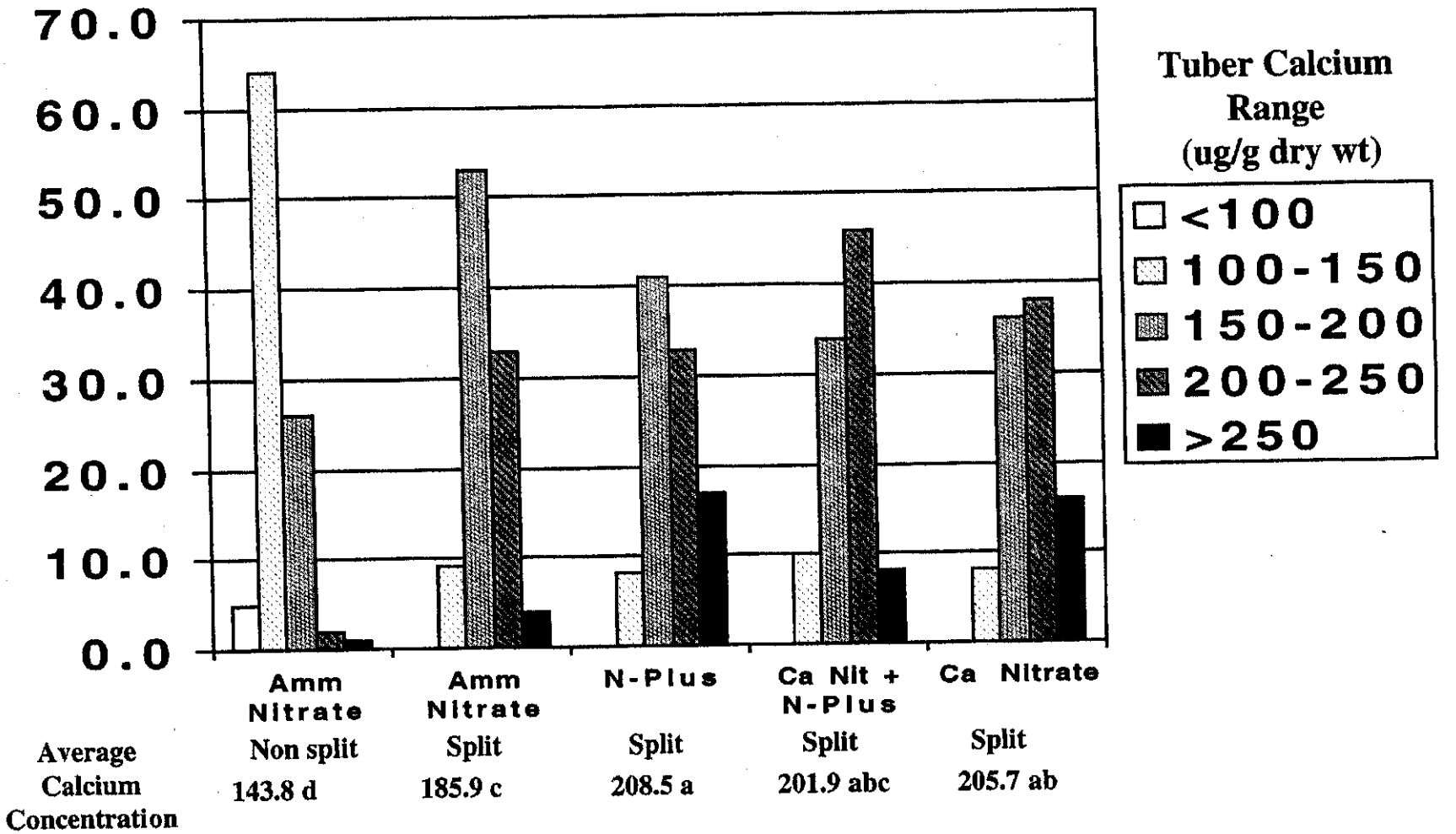
Figure 3: 1997 Frequency distrubution of calcium concentration cultivar: Burbank (treatments applied with calsol)



	Amm Nitrate Split	N-Plus Split	Ca Nit + N-Plus Split	Ca Nitrate Split
Average Calcium Concentration	194.2 bc	205.8 ab	210.9 a	207.0 ab

All treatments in figure 3 and 4 analyzed together

Figure 4: 1997 Frequency distrubution of calcium concentration cultivar: Burbank (treatments applied without calsol)



All treatments in figure 3 and 4 analyzed together

Table 4: 1998 results

Treatment	HH* % Tubers		IBS** % Tubers	
Amm Nitrate-Calsol(nonsplit)	0.53	abc	5.80	a
Amm nitrate+Calsol (nonsplit)	1.00	a	3.40	abc
Amm Nitrate-Calsol(split)	0.26	bc	2.78	c
Amm Nitrate+Calsol (split)	0.25	bc	4.25	abc
$Ca(NO_3)_2$-Calsol	0.12	bc	4.60	abc
$Ca(NO_3)_2$+Calsol	0.64	abc	3.33	abc
$CaCl_2$+Urea+CaNO3	0.28	bc	3.06	abc
$CaCl_2$ +Urea (60 lb ca)	0.00	c	2.41	c
$CaCl_2$+Urea (82.5 lb ca)	0.38	bc	2.80	c
$Ca(NO_3)_2$+N-Plus-Calsol	0.95	ab	3.03	bc
$Ca(NO_3)_2$+N-Plus+Calsol	0.57	abc	5.27	abc
N-Plus-Calsol	0.52	abc	4.25	abc
N-Plus+Calsol	0.30	bc	5.70	ab
UAN(0 lb ca)	1.37	a	3.58	abc
UCAN(60 lb ca)	0.54	abc	2.38	c
UCAN(82.5 lb ca)	0.17	bc	3.56	abc

LSD (α=0.1)

*Hollow Heart: **Cavity of any perceptible size** in center of medullary tissue with or without discoloration.

Internal Brown Center: **Any spot contained inside of vascular ring in the medullary tissue but **not in the center**.

(For explanation on UAN and UCAN see table 1)