EFFECT OF NITROGEN MANAGEMENT ON RUSSET BURBANK TUBER DORMANCY AND RESPONSE TO CIPC

by
Mike Thornton, Mike Lewis, Gale Kleinkopf, Tina Brandt,
Terry Tindall, and Christine Falen, University of Idaho

Application of chlorpropham (CIPC) to potatoes in storage has been a common practice for many years. A single treatment with CIPC can suppress sprouting and allow marketing of tubers from storage for up to 12 months. However, not all applications seem to be equally effective in suppressing sprouting. A second treatment is often required in some storages to adequately control sprouting. Even within a given storage there can be variation in the level of sprout control achieved with CIPC. Most often the lack of control with CIPC application is blamed on misapplication , poor distribution or lack of chemical efficacy. Very little research has been conducted to determine how the physiological condition of the tubers in storage might impact their reaction to sprout inhibitors.

Cultural practices that result in plant stress are have been shown to affect tuber storage characteristics. Immature or over mature tubers may exhibit increased reducing sugar content, higher weight loss and increased sprouting compared to mature tubers (Iritani and Sparks, 1985). The objective of this study was to determine how tuber maturity, as influenced by nitrogen nutrition, affects tuber dormancy and response to CIPC.

METHODS

Russet Burbank tubers were harvested from nitrogen fertilization trials at the University of Idaho Research and Extension Center in Parma on September 10, 1992 and September 24, 1993. One week prior to harvest, the vines were flailed to facilitate mechanical harvesting. The trials were designed as randomized complete blocks with four replications and four nitrogen rates. All side dress nitrogen was applied in one or two split applications beginning after tuber initiation. The exception was the 286 lbs/acre treatment in 1992 where nitrogen was applied over a seven week period. The nitrogen rates were as follows:

This Presentation is part of the Proceedings of the 1996 Washington State Potato Conference & Trade Show.

Year	Preplant N Rate (lbs/acre)	Side Dress N Rate (lbs/acre)	Total N Rate (lbs/acre)
1992	80	0	80
	80	80	160
	80	160	240
	80	206	286
1993	100	0	100
	100	100	200
	100	200	300
	150	250	400

Vine maturity was evaluated by estimating the % of vines in each plot that were infected with verticillium wilt in late-July to early August. Tuber maturity was evaluated by measuring specific gravity and sucrose concentration prior to harvest. Approximately 400 lbs of 6 to 10 oz tubers were collected from each plot and separated into mesh bags containing 20 tuber samples for subsequent analysis in storage. The randomization pattern from the field was maintained during the storage phase of the project. The tuber samples were initially cured at 55°F and 90% RH in cold storage rooms at Parma. After curing the tuber samples were transported to a storage research facility and placed into wooden storage bins that contained an air plenum to ensure proper air distribution. To prevent cross-contamination with CIPC, sample bins for treated and untreated tubers were placed into separate rooms that had individual air systems. Bins that contained samples to be treated with CIPC were lined with plastic so that they could be sealed during chemical treatment. Storage temperatures were gradually reduced from 50°F to the holding temperature of 45°F.

Potatoes were treated with CIPC on December 14, 1992 and November 30, 1993 by injection as an aerosol into the air distribution system. The aerosol was recirculated through the enclosed air system for 4 hours. The air system was subsequently shut off for 24 hours to allow the aerosol to deposit on the tubers, then the plastic liner was opened and the air system restarted. CIPC residues were determined on whole tuber samples that had been washed to remove the soil prior to analysis. Subsequent analysis of unwashed samples indicated that washing reduced tuber CIPC concentration by an average of 0.14 ppm.

Untreated and CIPC treated potatoes were periodically evaluated for sprouting. The number of sprouts > 0.2 inches in length and the total weight of sprouts were measured on each date. Sprout ratings for all tubers in each sample were averaged to provide a mean value for statistical analysis.

RESULTS

Plant and Tuber Maturity - High nitrogen fertilizer rates reduced the proportion of plants exhibiting symptoms of verticillium wilt in comparison to low rates (Table 1).

The high proportion of plants exhibiting wilt symptoms in the 80 and 100 lb/acre N treatments indicates early vine senescence that would contribute to over mature tubers at harvest. Nitrogen treatments significantly affected tuber maturity, as indicated by specific gravity and sucrose content.

CIPC Concentration - Nitrogen treatment in the field had no affect on the concentration of CIPC on tubers after treatment in storage (Figure 1). CIPC residues increased between the January 4 and 25 sample dates, then declined during subsequent storage. CIPC residue levels were lower than expected to occur after a commercial application, but appeared to be sufficient to control sprouting during the storage period.

Sprouting

1992 Trial - Both nitrogen and CIPC significantly affected sprouting. Tubers that were not treated with CIPC broke dormancy and began to rapidly sprout by January 4, 1993 (Figure 2). In contrast, tubers treated with CIPC did not show signs of sprouting until March (Figure 3). The number of sprouts increased rapidly after sprouting began, especially in tubers not treated with CIPC (Figure 2). Nitrogen treatment significantly affected sprout number on all dates. Tubers grown at low nitrogen rates broke dormancy earlier and produced more sprouts than tubers grown at high N rates. Sprout weight was also increased in storage by low N rate, but the effect was not significant until March 15th. There was a significant N by CIPC treatment interaction, with tubers from high N rates treated with CIPC exhibiting much lower sprout number and sprout weight. The effect of nitrogen on sprouting occurred in both CIPC treated and untreated tubers.

1993 - Tubers that were not treated with CIPC broke dormancy and exhibited rapid sprout growth by February 11, 1994 (Figure 4). Tubers from the high N treatments had lower sprout lengths than the low N treatments on February 11, but there was no treatment effect at later sampling dates. CIPC delayed sprouting of tubers from all N treatments (Figure 5). Tubers from the low N treatments had begun to sprout by the final evaluation on June 1, while tubers from the high N treatments were still dormant.

SUMMARY

These results indicate that premature plant death due to nitrogen stress significantly shortens tuber dormancy, resulting in early sprout growth. This effect occurs even when CIPC is applied before tubers show signs of sprouting. As expected, tuber CIPC residues were not affected by the nitrogen treatment. This indicates that the physiological status of the tuber was primarily responsible for this early sprouting. The response of sprouting to nitrogen treatment was stronger in tubers grown during the summer of 1992 than in 1993. This may be in part explained by the higher soil temperatures experienced during 1992 (data not shown). Warm soil temperatures after vine senescence may increase the rate of physiological aging and shorten the dormancy of tubers.

Potato cellars often exhibit pockets of intense sprouting, even after CIPC application. The locations where poor sprout control occurs are often blamed on poor chemical distribution or efficacy. These results indicate that an additional explanation may be tuber maturity. Locations where early sprouting occurs may contain tubers from portions of fields that experienced premature vine death due to stress (disease, water, nutrients, etc.).

ACKNOWLEDGMENTS

We thank Ore-Ida foods for supplying storage facilities and Elf Atochem North America for providing CIPC residue analysis. Without these contributions this study would not have been possible.

References

Iritani, W.M. and W. C. Sparks. 1985. Potatoes: Storage and quality maintenance in the Pacific Northwest. PNW Bulletin 257.

Table 1. Effect of nitrogen treatment on expression of verticillium wilt, specific gravity and sucrose content in Russet Burbank.

Nitrogen Rate (lbs/acre)	Verticillium Wilt[x] (%)	Specific Gravity[y]	Sucrose Conc.[z] (% Dry wt. basis)
1992			
80	60	1.095	1.04
160	25	1.089	0.97
240	15	1.085	1.10
286	5	1.074	0.72
F-test	**	**	**
1993			
100	21	1.092	0.66
200	3	1.086	0.58
300	2	1.085	0.61
400	1	1.080	0.64
F-test	*	*	NS

[x] Portion of vines exhibiting symptoms of verticillium wilt on August 6 (1992) or July 29 (1993).

[y] Specific gravity of tubers on July 31 (1992) or August 12 (1993).

[z] Sucrose concentration was measured with a Yellow Springs Instruments Model 27 on September 10 (1992) or September 24 (1993).

Figure 1. CIPC residues on tubers stored during 1992-1993 at 45 F.

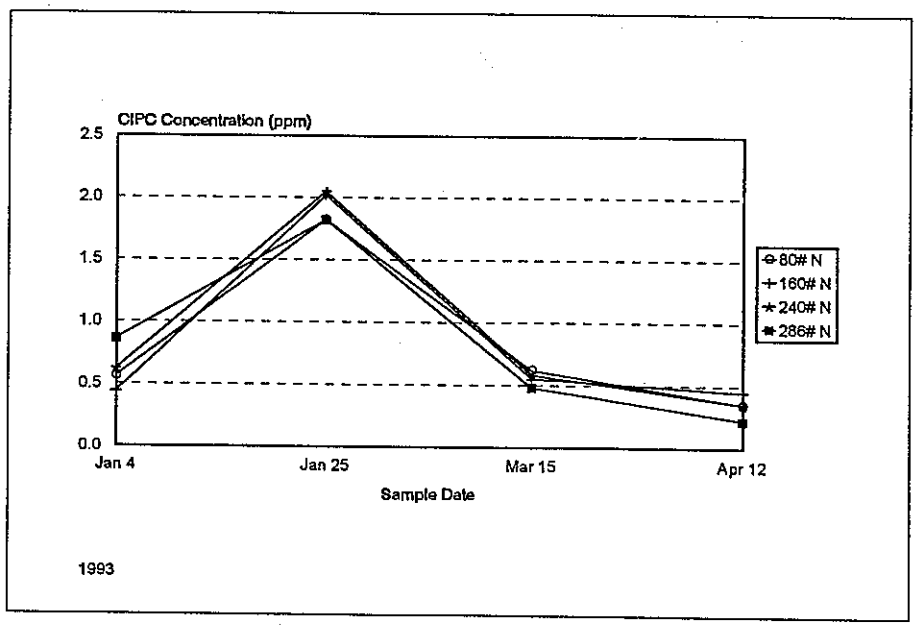

Figure 2. Effect on nitrogen rate on sprout growth of tubers not treated with CIPC during storage at 45 F in 1992-1993.

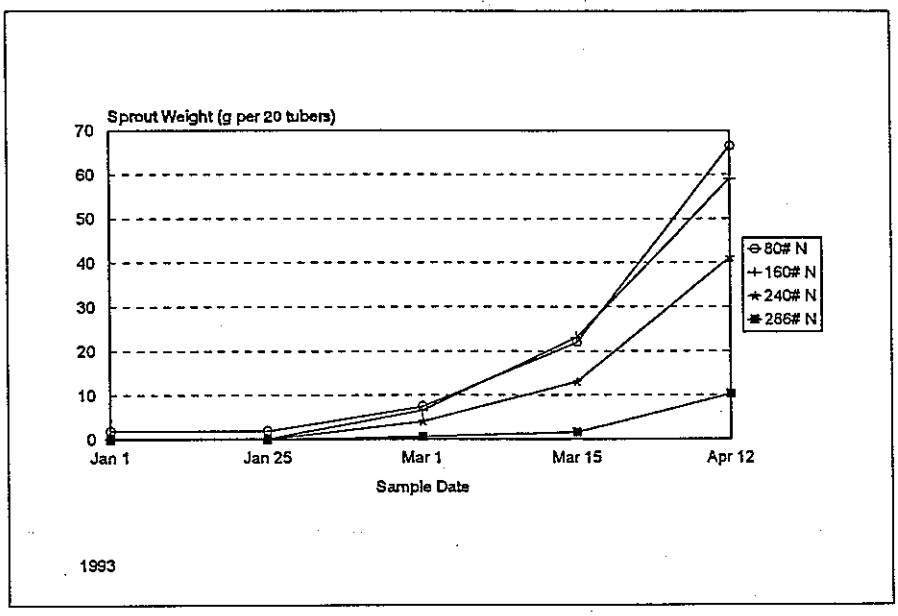

Figure 3. Effect of nitrogen rate on sprout growth of CIPC treated tubers during storage at 45 F in 1992-1993.

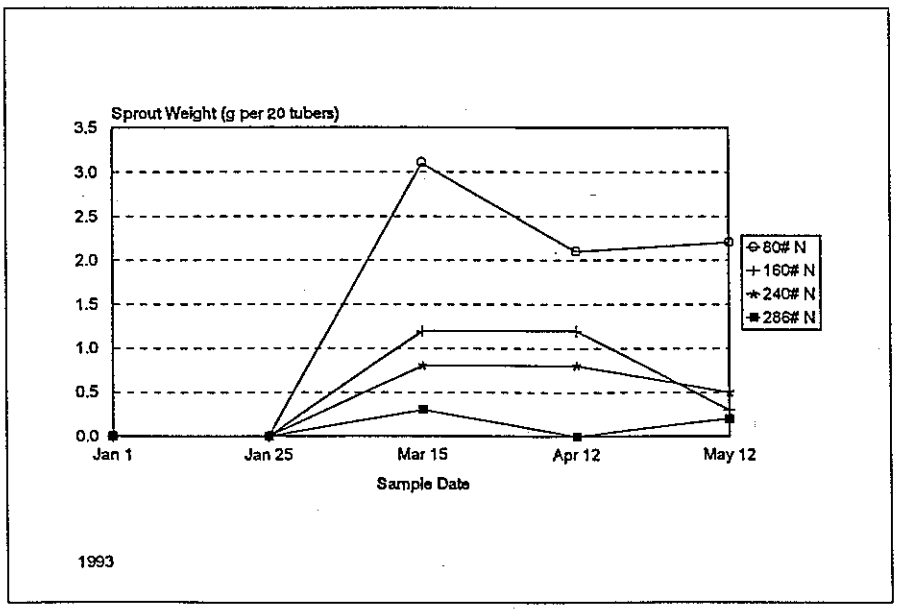

Figure 4. Effect of nitrogen rate on sprout growth of tubers not treated with CIPC during storage at 45 F in 1993-1994.

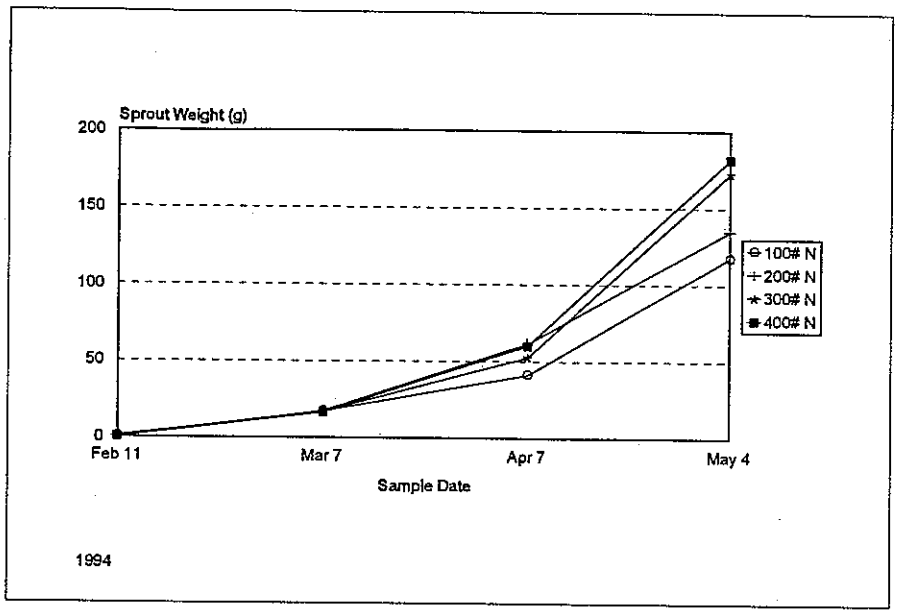

Figure 5. Effect of nitrogen rate on sprout growth of CIPC treated tubers during storage at 45 F in 1993-1994.