Effect of Variations In Ammonium Nitrate Equivalent, Free Water, And Ammoniation Rate The validity of the above theory was checked by a series of experiments wherein fertilizers were manufactured with varying ammonium nitrate equivalent contents, while the phosphorus and potash were held constant at 12 and 12. To clarify the problem further, free water and ammoniation rate were likewise varied in separate series. Results of these tests are shown in Table VI and plotted in Figure 8.

Each group of tests contained a common mix (4-N, 2-W, 2-A), and it was interesting to note the good checks in caking tendencies among these similar mixes. Although there was some variation from the anticipated curve (Table I), after 3 weeks' curing the trend plainly indicated ammonium nitrate equivalent to be a substantial contributor to caking, water content to be almost negligible with a slight downward trend, and ammoniation rate to be detrimental initially with no marked effect after 3 weeks' cure. The last noted phenomenon is in line with other work which indicated greater disturbance of the water of hydration of calcium phosphates with increased ammoniation rate.

These conclusions are valid only so long as no change is made in the physical characteristics or normal water content of the superphosphate, as these appear to be important factors in the caking of mixed goods.

Summary

The experimental information indicated that caking in high potash fertilizer could be controlled to some degree by control of the ammonium nitrate equivalent. Increasing the ratio of ammonia to ammonium nitrate in ammoniating solutions improved the conditioning effect. Above a certain moisture content, "free" water did not contribute to caking, and the effect of ammoniation rate was transitory. Metathesis played an important part in caking.

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SWEET POTATOES

Physiological and Biochemical Effects of Maleic Hydrazide on Pre- and Postharvest Behavior

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This work is a part of a general study on the storage behavior of sweet potatoes, carried on during several seasons. Preharvest foliar sprays of maleic hydrazide have been used with other root crops to reduce sprouting and prolong the commercial storage life. This work was to determine the effect of similar sprays on the pre- and postharvest behavior of sweet potatoes. Preharvest foliar sprays had little if any visible effect on the foliage and no significant effect on the accumulation of carotenoid pigments in the roots during the interval between treatment and harvest. However, the treatment caused surface pitting of the harvested roots and seriously interfered with the normal synthesis of provitamin A (carotene) and other carotenoid pigments during storage.

USE OF PREHARVEST FOLIAR SPRAYS of maleic hydrazide to inhibit sprout formation and prolong the storage life of several bulb, tuber, and root crops has been reported (*4, 8, 9*).

Intact onion plants sprayed 2 weeks before harvest with 2500 p.p.m. of maleic hydrazide showed no sprouting after 1 month at 35° F. plus 4 months at 55° F. (*9*). Flavor, color, and odor were apparently not affected. The treated bulbs remained dormant for 8 weeks when planted in the greenhouse while nontreated bulbs grew normally and produced large vegetative tops.

Table I. Carotenoid Pigments in Sweet Potatoes as Affected by Preharvest Foliar Sprays of Maleic Hydrazide

Variety and Treatment	Carotene: At harvest, mg./100 g.	Carotene: After storage, mg./100 g.	Carotene: Difference, %	Total Carotenoids: At harvest, mg./100 g.	Total Carotenoids: After storage, mg./100 g.	Total Carotenoids: Difference, %
Orange Little Stem						
Control A, unsprayed, harvested when spray applied	4.92	6.26[a]	27.2	5.60	7.16[a]	27.9
Control B, unsprayed, harvested 27 days after spray applied	5.88	7.05[a]	19.9	6.58	7.73[a]	17.5
Maleic hydrazide, harvested 27 days after treatment	5.49[b]	5.45[c]	−0.7	6.36[b]	6.14[c]	−3.5
Yellow Jersey						
Control A, unsprayed, harvested when spray applied	0.15	0.89[a]	493.3	0.74	1.92[a]	159.5
Control B, unsprayed, harvested 23 days after spray applied	0.16	[d]	...	0.76	[d]	...
Maleic hydrazide, harvested 23 days after treatment	0.14[b]	0.25[a, e]	78.6	0.69[a]	0.94[a, e]	36.2

[a] Difference between "at harvest" and "after storage" significant at 1% level.
[b] Rate of change in field not significantly different in treated and control.
[c] Difference between "at harvest" and "after storage" not significant.
[d] Storage sample lost, but other Yellow Jersey roots harvested following day from nearby area increased much more than maleic hydrazide–treated lot.
[e] Rate of change in storage in sprayed and control lots significantly different at 1% level.

Carrots similarly sprayed 4 days before harvest were clean, smooth, bright, and free from sprouts after 3 months' storage at 50° F. and showed no significant differences in dry matter, carotene carbohydrates, or Kjeldahl nitrogen resulting from the treatment. A similar spray applied to the foliage of Irish Cobbler and Pontiac potatoes 1 to 7 weeks before harvest caused no reduction in size, quality, or yield (*4*). After 7 months at 45° and at 55° F. the treated tubers were practically free of sprouts, while the control lots had sprouted profusely. After storage there was no difference in percentage of dry matter, starch, or other acid-hydrolyzable polysaccharides, total carbohydrates, or Kjeldahl nitrogen between the treated and the controls. The treated lots especially when stored at 45° F. gave lower values for both reducing and nonreducing sugars. During a 35-day storage period treated sugar beets lost only 0.72% of their original sugar content, while the unsprayed control lost 13.06% (*8*). The sprayed roots showed practically no top growth, root growth, or storage breakdown, whereas considerable growth and breakdown occurred in the control.

While the use of maleic hydrazide as an adjunct to long-term storage of several bulb, tuber, and root crops thus appears to have considerable possibilities, published results indicate that it may have relatively little effect on sweet potatoes. Moore (*3*) reported that sweet potato vines were apparently unaffected by a concentration of 2400 p.p.m. Simons and Scott (*5*) found that 2500 p.p.m. had no observable effect on the foliage or the roots of Maryland Golden and Porto Rico sweet potatoes at time of harvest. There was no significant effect on yield, sprouting in storage, moisture content, alcohol-insoluble solids, reducing sugars, or nonreducing sugars at harvest or after curing. When the roots were bedded there was an increase in the number of sprouts produced, but they were malformed as if they had been sprayed with 2,4-D. In the present study it was shown that harmful effects in storage may result from use of maleic hydrazide on sweet potatoes.

Materials and Methods

Orange Little Stem and Yellow Jersey sweet potatoes were grown on a Chillum sandy loam at the Plant Industry Station, Beltsville, Md. Both varieties were grown in the same field, were planted at the same time, and received similar treatment prior to the spray applications. Orange Little Stem vines were sprayed with maleic hydrazide at a concentration of 3300 p.p.m. applied at the rate of 8 pounds of actual maleic hydrazide per acre 27 days before harvest. No effect of the spray was evident on the foliage within 1 week. Yellow Jersey vines were then sprayed with twice the previous amount (6600 p.p.m. and 16 pounds per acre), without visible injury to the foliage, 23 days before harvest. Roots from unsprayed vines from adjacent rows were harvested when the spray was applied (Control A) and again when the treated lots were harvested (Control B).

The harvested roots were washed to remove adhering soil and weighed individually, and the weight in grams of each root was recorded thereon with an indelible pencil; the roots were reweighed at time of analysis. The roots for storage were cured at 85° F. for 8 days and then held at 60° F. for approximately 5 months, when they were removed for analysis.

Methods and general procedures for carotenoid determinations have been described (*1*). Each sample consisted of 10 replicates of 5 roots each. Longitudinal sections of each of the 5 roots were ground in a food chopper and mixed thoroughly. Duplicate 20-gram samples were then analyzed by the Wall and Kelley method (*7*). Carotene was separated from the other carotenoids by chromatographing an aliquot of the petroleum ether extract. Total carotenoids were determined on a separate portion of the extract without chromatographing. Both were read in a photoelectric colorimeter with a 440-mμ filter. The results of the duplicates were averaged and the amount reported is the average of the 10 replicates calculated back to the weight at harvest. Analysis of variance was used to determine the significance of difference between treatments.

Results

The sprayed vines showed no visible injury from the treatment at any time and at harvest appeared to be slightly greener than the controls. The Orange Little Stem roots, harvested 27 days after treatment, appeared normal at harvest, but a gelatinous exudate was noted on a few roots after a short exposure to the atmosphere and numerous pock marks were evident the following day (Figure 1). The Yellow Jersey roots, harvested 23 days after treatment, when frost was forecast, also appeared normal at harvest. No gelatinous exudate was observed on these roots, but numerous pock marks were readily evident the following morning, both varieties being about equally affected. Samples analyzed at time of harvest (Table I) showed a normal increase in carotene and total carotenoids during the interval between treatment and harvest for both the treated and the control lots of Orange Little Stem. The rate of increase was not significantly different in the two lots. In Yellow Jersey the rate of increase during the growing season is normally much slower than in the Orange Little Stem (*2*) and no significant change occurred in either the control or the treated lots during this period. The maleic hydrazide spray thus had no statistically significant effect on the accumulation of carotenoid pigments during the 3- to 4-week interval between treatment and harvest. However, as shown in Table I, it had a highly significant effect on the postharvest behavior of the roots. The accumulation of carotene and other carotenoid pigments was prevented in Orange Little Stem and the rate of accumulation was significantly reduced in Yellow Jersey by the spray.

Why Orange Little Stem was more severely affected by the treatment than Yellow Jersey, which received the heavier application, is not known. The Yellow Jersey received the spray 1 week later than the Orange Little Stem, but the weather and growing conditions were not greatly different at the time of and following the spray applications. Because of a frost forecast, the interval between treatment and harvest was 4 days less for Yellow Jersey than for Orange Little Stem, but otherwise conditions were similar. Tatum and Curme (*6*) reported a pronounced differential response of strains of corn to maleic hydrazide and to different concentrations, and it may well be that a difference in varietal characteristics is responsible in this case.

That the Orange Little Stem was more affected by the chemical than Yellow Jersey is also indicated in Table II. The treated lot of Orange Little Stem showed appreciably more decay and the sound roots lost significantly more weight during curing and storage, as compared with the controls, than Yellow Jersey. Unpublished work by the authors indicates that unfavorable conditions before harvest may cause the roots to lose weight more rapidly in storage than those grown under favorable conditions.

Other workers (*4*, *5*, *9*) found that maleic hydrazide foliar sprays had no detrimental effect on yield. While direct yield records were not obtained in this study, there was no indication that the spray treatment reduced the yield in these tests. No objective tests on the efficacy of maleic hydrazide in retarding sprout development in sweet potatoes were included in this study. However, it was observed that while the treated roots were not entirely free from sprouts, they had fewer sprouts than the controls. Sprouting in storage was not a factor of much importance even on the controls. Simons and Scott (*5*) reported no significant effect of maleic hydrazide on sweet potato sprouting in storage. When the roots were bedded, more sprouts were produced, but were malformed as if they had been sprayed with 2,4-D.

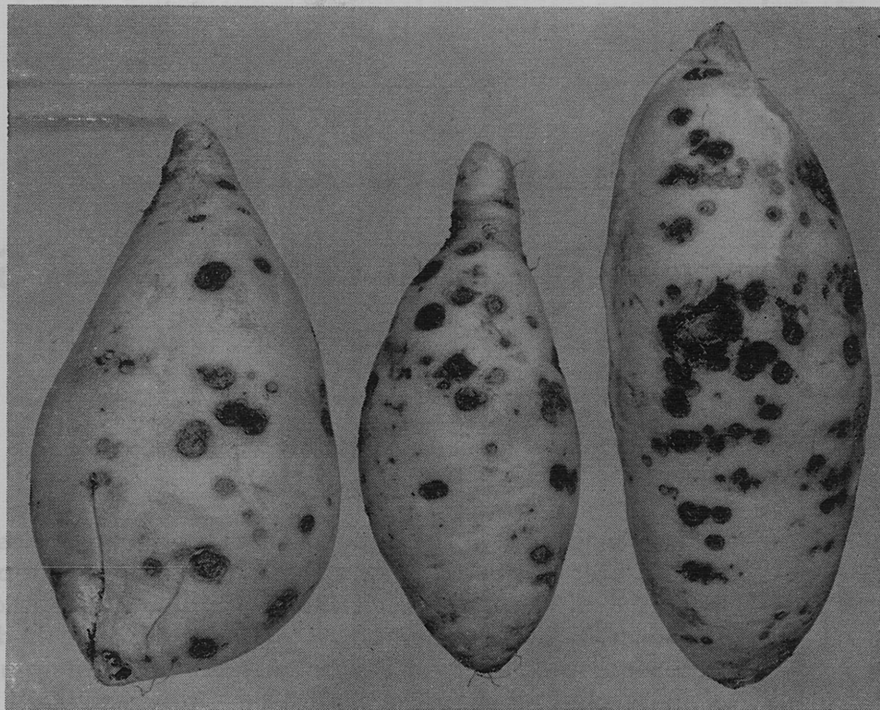

Figure 1. Pock marks on Orange Little Stem sweet potatoes from vines sprayed with maleic hydrazide

Table II. Decay and Loss of Weight of Sweet Potatoes in Storage as Affected by Preharvest Foliar Sprays of Maleic Hydrazide

Variety and Treatment	*Date Harvested*	*Days in Storage*	*No. of Roots*	*Decay, %*	*Loss in Weight, %*
Orange Little Stem					
Control A, unsprayed, harvested when spray applied	Sept. 12	184	60	10	10.8
Control B, unsprayed, harvested 27 days after spray applied	Oct. 9	161	64	12	13.7
Maleic hydrazide, harvested 27 days after treatment	Oct. 9	161	61	54	16.2
		161	60	38	
Least significant difference					
1%					2.14
5%					1.58
Yellow Jersey					
Control A, unsprayed, harvested when spray applied	Sept. 19	176	66	2	11.9
Maleic hydrazide, harvested 23 days after treatment	Oct. 12	158	57	4	12.5
		314	59	7	
		314	69	1	
Least significant difference					
1%					0.88
5%					0.64

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