The Influence of Nitrogen and Potassium Nutrition on Vine and Root Development of the 'Allgold' Sweetpotato at Early Stage of Storage Root Enlargement[1]

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Abstract. Plants of the 'Allgold' sweetpotato were grown for 60 days with 3 levels of N and K in a peat-perlite medium to determine the influence of these nutrients on plant development early in the stage of root enlargement. Dry vine and fresh root weights were highly correlated, with high N and medium K resulting in the largest vine and root weights. The numbers of roots were influenced more by K than by N, but the size of roots was influenced more by N than by K. The addition of N without K was responsible for long roots, and the addition of K reduced root length at all N levels.

Considerable research has been done on the nutrition of sweetpotato, but most data have been recorded on the matured root at the end of the growing season. These data show that N and K, particularly, have a pronounced effect on yield (1,2,3,4,5,6,7,9,10,19,20) and root shape (5,11,12,13,15,18,20). The objective of this study was to obtain insight on what influence N and K fertilization have on the vine and storage root development early in the stage of storage root enlargement rather than at the end of the growing season. Information on the time of storage root enlargement is unknown for many cultivars, but it was observed during 3 years of growing 'Allgold' plants that root enlargement began between 50 to 60 days after planting. Scott (14), in studying K uptake throughout the growing season by 'Maryland Golden' and 'Porto Rico' plants, observed storage root thickening about 80 days after planting.

Materials and Methods

Nutritional studies were conducted in the greenhouse from June 27 to August 27. The growing medium was 1:1 mixture of a horticultural grade peat moss and perlite. The cation exchange capacity of the mixture was 50.2 me/100g. The materials were thoroughly mixed, placed into 3 gal glazed crocks, and flushed with the different nutrient solutions prior to transplanting 4-week-old slips into the medium. The slips were produced from roots that were bedded in washed and sterilized sand.

The experimental design was a split-plot with the N-levels in the main plots and the K-levels in the sub-plots. The treatments were 0 (low-N_0), 140 (medium-N_1), and 280 (high-N_2) mg/l of N applied as NH_4NO_3, and 0 (low-K_0), 195 (medium-K_1), and 390 (high-K_2) mg/l of K applied as K_2SO_4. Phosphorous was applied to each treatment at the rate of 227 mg/l of P as H_3PO_4. The nutrient solutions were applied every 2 weeks from June 24 to August 13. Dolomitic limestone was mixed with the peat-perlite at the rate of 5 lb/yd^3 as the source of Ca and Mg.

Table 1. Influence of N and K on dry wt (g/plant) of sweetpotato vines at 3 periods of growth.

No. of growing days	N-level	K-level K_0	K_1	K_2	mean
15	N_0	0.97	0.78	0.74	0.83
	N_1	0.88	0.92	0.96	0.92
	N_2	0.93	1.09	1.40	1.14
	Mean	0.93	0.93	1.03	
	L.S.D. 5% N				0.14
	L.S.D. 5% K				ns
	L.S.D. 5% N within K				0.20
	L.S.D. 5% K within N				0.23
30	N_0	1.08	1.56	1.44	1.36
	N_1	2.76	2.98	2.30	2.68
	N_2	1.79	3.14	3.49	2.81
	Mean	1.88	2.56	2.41	
	L.S.D. 5% N				0.37
	L.S.D. 5% K				0.57
	L.S.D. 5% N within K				0.76
	L.S.D. 5% K within N				0.95
60	N_0	1.64	2.27	2.09	2.00
	N_1	3.34	4.85	6.87	5.02
	N_2	3.03	9.28	5.56	5.96
	Mean	2.67	5.47	4.84	
	L.S.D. 5% N				1.16
	L.S.D. 5% K				0.60
	L.S.D. 5% N within K				1.05
	L.S.D. 5% K within N				1.30

Table 2. Influence of N and K on mean fresh root wt (g/plant), mean number of storage roots per plant, and avg wt (g) per/root for sweetpotato plants after 60 days of growth.

	Fresh root wt				No. of roots				Avg wt/root			
	K-level				K-level				K-level			
N-level	K_0	K_1	K_2	mean	K_0	K_1	K_2	mean	K_0	K_1	K_2	mean
N_0	39.5	38.1	38.3	38.6	5.7	4.0	3.0	4.2	6.9	9.5	12.7	9.7
N_1	44.0	103.8	131.4	93.1	3.7	7.7	10.2	7.6	11.9	13.5	12.9	12.8
N_2	71.6	195.2	126.8	131.2	3.0	7.3	9.0	7.1	15.9	26.7	14.1	21.6
Mean	51.7	112.4	98.8		4.1	6.1	7.9		11.6	16.6	13.2	
L.S.D. 5% N				2.8				0.3				1.9
L.S.D. 5% K				6.8				0.4				1.6
L.S.D. 5% N within K				11.8				0.7				2.7
L.S.D. 5% K within N				8.7				1.4				2.6

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The treatments were replicated 4 times.

Four plants were transplanted into each crock for each treatment. Top growth (stems and leaves) were harvested from 2 of the 4 plants in each treatment plot just prior to the addition of nutrients on July 12. Another plant was harvested prior to the addition of nutrients on July 22. The top growth and storage roots of the remaining plant in each plot were harvested on August 27. Main stem length and length and diam measurements of storage roots were recorded. The top growth was dried at 140°F, weighed, and analyzed for total N and K. Total N was determined by the Kjeldahl method. Potassium was determined on the flame spectrophotometer.

Results and Discussion

During the first 30 days, prior to storage root enlargement, the plants grown with the highest levels of N and K produced the heaviest wt of vine growth (Table 1). However after 60 days the vine growth of the plants grown with high N and medium K was the heaviest; but, either an additional increment in N (high N over medium N) with high K; or an additional increment in K (high K over medium K) with high N reduced vine wt. The plants that made the greatest vine growth also had the highest mean wt of fresh storage roots (Table 2). The relationship between vine and root wt at 60 days was highly significant (Table 5). An increase in K without N had no effect on root wt but an increase in N without K increased the wt of roots. The largest mean root wt were obtained from plants grown with high N and medium K, and like vine growth, fresh root wt was reduced by the additional increment of K (high K) with high N.

Table 3. Influence of N and K on length to diameter (L/D) rates of sweetpotato storage roots at 60 days of growth.

N-level	K-level K_0	K_1	K_2	Mean
N_0	5.12	4.77	4.57	4.82
N_1	5.77	5.35	5.18	5.43
N_2	7.99	6.47	5.93	6.80
Mean	6.29	5.53	5.23	
L.S.D. 5% N				0.69
L.S.D. 5% K				0.44
L.S.D. 5% N within K				0.76
L.S.D. 5% K within N				0.83

Table 4. Influence of N and K on N and K content (% dry wt) of sweetpotato vines at 60 days of growth.

N-level	N (%) K_0	K_1	K_2	Mean	K (%) K_0	K_1	K_2	Mean
N_0	2.50	2.33	1.53	2.12	1.29	2.75	2.61	2.22
N_1	3.43	3.00	2.93	3.12	1.17	3.20	4.50	2.96
N_2	5.00	4.87	4.73	4.87	1.67	3.58	3.86	3.04
Mean	3.62	3.40	3.07		1.38	3.18	3.66	
L.S.D. 5% N				0.18				0.34
L.S.D. 5% K				0.26				0.29
L.S.D. 5% N within K				0.45				0.50
L.S.D. 5% K within N				0.39				0.88

Both N and K are necessary for large numbers of storage roots (Table 2), and the highest numbers of roots were obtained from plants grown with either medium N and high K, or high N and high K. The number of roots per plant was significantly correlated with the percent K but not with the percent N in the vine (Table 5). An increase in either N without K, or K without N reduced the numbers of storage roots and consequently increased the average wt/root. Mean root size was influenced more by the addition of N than by the addition of K, and the largest roots were produced on plants grown with high N and medium K. Root size was correlated with dry vine wt (Table 5).

The influence of N was more pronounced than the influence of K on storage root shape (Table 3). The largest length to diam (L/D) root ratios were obtained from plants grown with high N, and the addition of K reduced root length or increased root width to some extent at all levels of N. Plants grown with high N without K produced roots with the largest L/D ratio. Nitrogen, but not K, contents of vines was highly correlated with L/D ratios (Table 5).

An increase of N in the medium increased the N content of the vines, but an increase of K in the medium decreased the N content of the vines (Table 4). Increases of both N and K in the medium increased the K content in the vines.

Growth, as measured by dry vine wt, was not significantly correlated with the percent N but it was significantly correlated with the percent K in the vines (Table 5). However, the percent N in the vines was significantly correlated with the L/D ratios for the storage roots. Even though the addition of K was responsible for smaller L/D ratios, there was no significant correlation between the K content of the vines and the L/D ratios of the root after 60 days of growth.

The data indicate that N and K are required in a ratio of approximately 1.5 to 1, respectively, during early storage root development by sweetpotato plants growing in a high exchange capacity medium. This ratio of N to K is different from that usually found for fertilization of sweetpotatoes growing in sandy soils, because K is weakly absorbed (16) and easily leached (5) from such soils. Fertilizer recommendations for sweetpotato production are to apply N and K in ratios of 1:1 (20), 1:2 (8), 1:4 (3,4) and 1:6 (9) of N and K, respectively. The soil test analyses, according to the Spurway (17) method, showed for each treatment at the conclusion of this experiment that the peat-perlite medium had low retention of NO_3-N, none to traces, but it had high retention of the K ion. The correlation (0.830) between the amount of K retained by the growing medium and the percent K in the vines was highly significant.

Table 5. Correlation coefficients showing the interrelationships between variables measured.

	Fresh root wt	Root ratio (L/D)	No. of roots	Avg wt per root	% N	% K
Dry vine wt	0.978**	0.287	0.704*	0.812	0.567	0.731*
Fresh root wt		0.327	0.726*	0.818**	0.632*	0.737*
Root ratio (L/D)			-0.135	0.546	0.892**	-0.177
No. of roots				0.211	0.244	0.799**
Avg wt/root					0.665*	0.402
%N						0.147

*, ** Significant at 5 and 1%, respectively.

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