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9. ABSTRACT

The three objectives of this study were (1) to determine what combination of chemical nutrients, particularly nitrogen and potassium, would economically produce the best yields and quality of Williams Hybrid bananas; (2) to relate quality and yields to leaf contents of these nutrients; and (3) to determine the effect of plant density on yields and quality. Eight blocks of 48 plants each were planted on a two-acre plot of Kawaihapai gravelly clay loam pretreated with magnesium sulfate, phosphate, Eptam, and Ametryne. The blocks were fertilized variably with six levels of nitrogen and eight levels of potassium. Plant density was maintained at two levels. As bananas flowered, leaf samples were taken from the third youngest leaf lamina. Results showed that yields increased up to about 2.9% nitrogen, but 95% of maximum yield was obtained at about 2.7%N. Differences in bunch weights of this first harvest were not significantly related to the potassium treatments. The experiment is too young to give reliable data on the effects of plant density. However, the higher-density blocks produced 10% more flowering plants than the lower-density blocks.

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NUTRITION AND DENSITY STUDIES OF THE WILLIAMS HYBRID BANANA[1/]

BY

Robert M. Warner, Robert L. Fox and Suwit Prasomsook

A study of banana nutrition and planting density has been undertaken as a cooperative effort among the Oahu Banana Producers Association, the College of Tropical Agriculture, Cooperative Extension Service and the Hawaii Agricultural Experiment Station. The project had several objectives:

1. To determine what combination of chemical nutrients, particularly nitrogen and potassium, would produce economically the best yields and quality of the Williams Hybrid banana;

2. To relate quality and yields to leaf contents of these nutrients so that growers in other locations and other soil types would have a target at which to aim when planning fertilizer programs. (A quantometer which will perform most of these analyses quickly and at reasonable cost, is installed at the College and should soon be functional);

3. To make observations on the effect of plant density on yields and on other aspects of banana culture.

This kind of information is needed because grower experience and research guidance, available for Bluefields, Chinese and Brazilian bananas, is not available for Williams Hybrid.

Materials and Methods:

The experiment is growing on a gently sloping, 2-acre plot at Waimanalo. The soil is a Kawaihapai gravelly clay loam with neutral pH, moderate permeability and available water holding capacity of about 1.8 inches per foot in the surface soil and 1.6 inches per foot in the subsoil.

A "clean" banana nursery was established in July 1970 with planting material supplied by the Oahu Banana Growers Association whose members helped clean and heat-treat the corms. The experimental field was kept fallow for 1 year and treated with 100 lb/acre of magnesium in the sulfate form. One half of the field was given 200 lbs/acre of P in the form of trebble superphosphate. Eptam was applied for control of nutsedge and all were disced into the soil.

The experimental plots were planted the week of July 12, 1971. Preemergent herbicide, EVIC (Ametryne), aupplied by Ciba-Geigy Corporation, was applied over the new planting at 6.4 pounds of active ingredient per acre and sprinkler irrigated immediately. Excellent control of grasses and weeds other than nutsdege was obtained.

1/ Proceedings Hawaii Banana Industry Ass'n. 4: 8-18, University of Hawaii, CES Misc. Publ. 109. 1972.

The experimental design is a departure from the usual 16 mat plots. Eight blocks of 48 plants each were fertilized with 6 levels of N and 8 levels of K. Nitrogen increased progressively in one direction across blocks and K increased progressively across the block at 90 degrees to N. Thus each mat had a different N-K combination from every other mat in the block. A central treatment in each block i.e. (N4, K5) was sampled periodically for leaf analyses. The frequency and amount of fertilizer applied was adjusted to keep the 3rd leaf composition at about 2.6% N and 3.3% K. In other areas and for other varieties of bananas, this composition is considered to be approximately adequate.

Regardless of amounts and frequency of fertilizer added, relative amounts added to the various treatments were in a fixed ratio. Relative amounts of N for treatments 1 through 6 respectively were as follows: 0, 0.1, 0.3, 0.5, 0.7, 0.9. For K, relative amounts added for treatments 1 through 8 respectively were 0, 0.1, 0.2, 0.3, 0.5, 0.7, 0.9, 1.1. For example, in Table 1 the amounts of N in leaf samples taken April 26 were at or below the assumed critical level (2.6%) in blocks 1, 2, 3 and 4 but were above 2.6% in blocks 5, 6, 7 and 8. Therefore nitrogen was added to the first 4 blocks on May 17th. Thirty days later N levels in the leaves of all control plants were above 2.6%.

In the case of Potassium (Table 2) blocks 5 to 8 were below 3.3% and K was added on May 17th. This brought partial recovery in 20 days.

As bananas flowered (shot) leaf samples were taken from the third youngest leaf lamina. Height and girth of the pseudostem also were measured. At harvest, bunch weight and other measurements were taken.

Plant density was maintained at two levels. In low (L) density treatment the original and two suckers were allowed to develop. In high (H) density treatment the original plant and four suckers were allowed to develop. All others were periodically cut off at ground level. The density treatments and block layout are shown in Fig. 1.

Results and Discussion:

Most mats produced their first bunch by August 25, 1972. Mean weights for each treatment are given in Table 3. Each value is an average of 3 or 4 bunches. Nitrogen treatments 1 to 6, given as pounds of urea applied are shown across the top. The designation P_1 refers to blocks 5 to 8. These blocks received no phosphate. Designation P_2 refers to blocks 1 to 4 which received 200 lbs P per acre. Note that the zero and the 128 lb urea treatments have much lower bunch weights in the P_2 blocks where phosphate was added. Over the whole area where phosphate had been applied, a thick carpet of nutsedge almost a foot high developed. In blocks where no P had been added (P_1) only a few scattered nutsedge were observed. It is not clear whether the phosphate affected the eptam efficiency, or whether

it stimulated growth of the nutsedge. In any case, nutsedge competition evidently caused nitrogen deficiency which resulted in reduction of the bunch weights. Higher rates of N overcame this competitive effect. In Table 3 Potassium treatments, as KCl, are given at the left. Differences in bunch weights of this first harvest were not significantly related to the K treatments.

Yields in Table 3 can be converted to pounds per acre and divided by days from planting to harvest to give pounds per acre per day (PAD). When these values are plotted against percent N in the leaves at flowering, the curve shown in Fig. 2 results. Yields increased up to about 2.9% N but 95% of maximum yield was obtained at about 2.7% N. This is slightly higher than is usually reported as being adequate. This kind of information could be very useful to banana producers.

These critical levels are tentative. Later, when our results here are complete, growers can use leaf analyses to tell whether they should increase or decrease the amounts of fertilizer being used.

This banana experiment is too young to give reliable data on the effects of plant density. Preliminary indications, however, may be obtained by examining the number of plants which have flowered (shot). Table 4 shows this information for high and low density treatments as affected by nitrogen rates. The higher density produced 42 more flowering plants than the low density treatment; almost 10% more. The number of flowers increased up to the 5th rate of N then decreased. Potassium rates, Table 5, seem to have had little effect upon number of flowers produced so far.

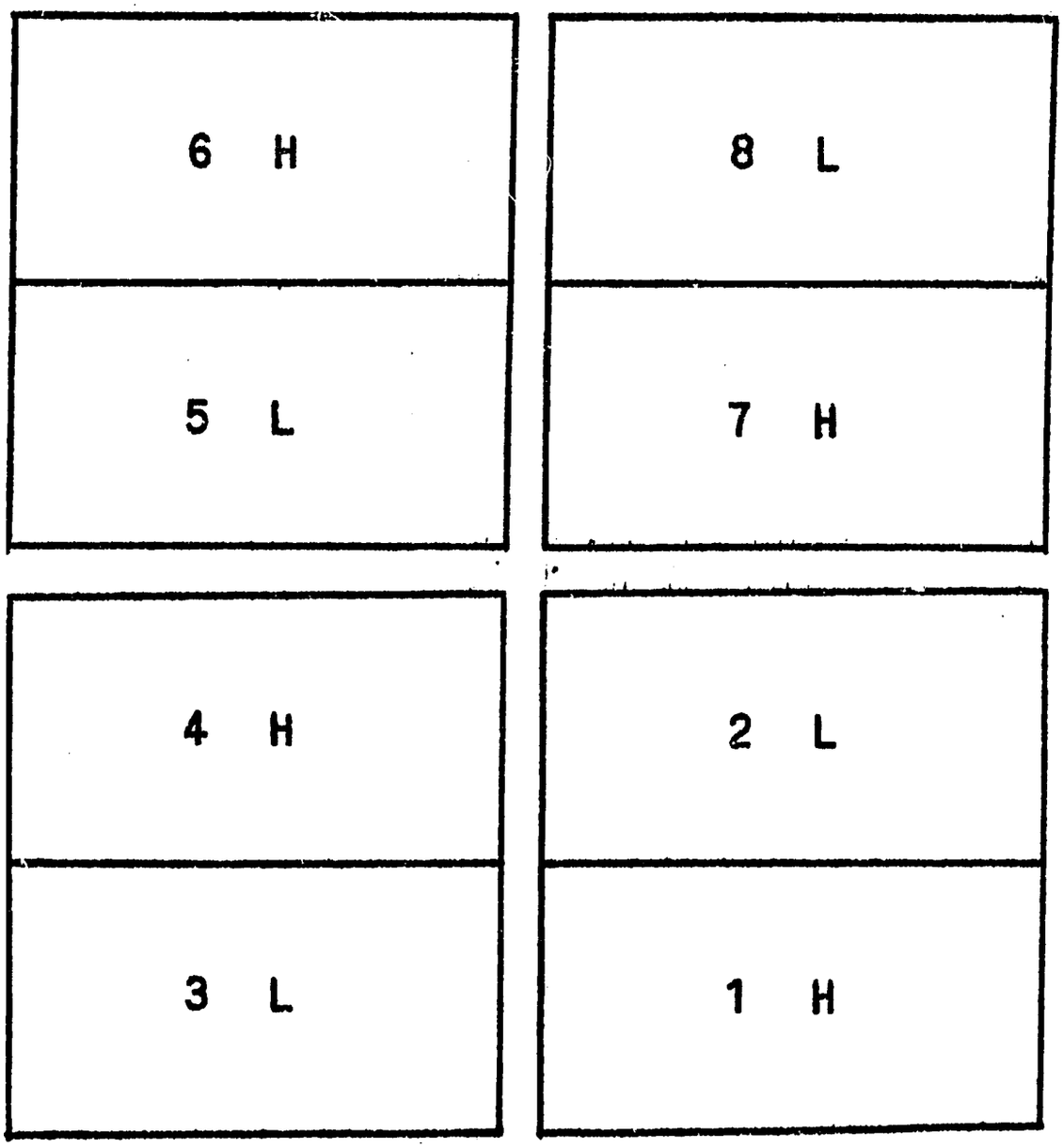

Fig. 1 Banana experiment block layout (1 to 8) and density treatments, high (H) and low (L). Phosphate was applied to blocks 1, 2, 3 and 4.

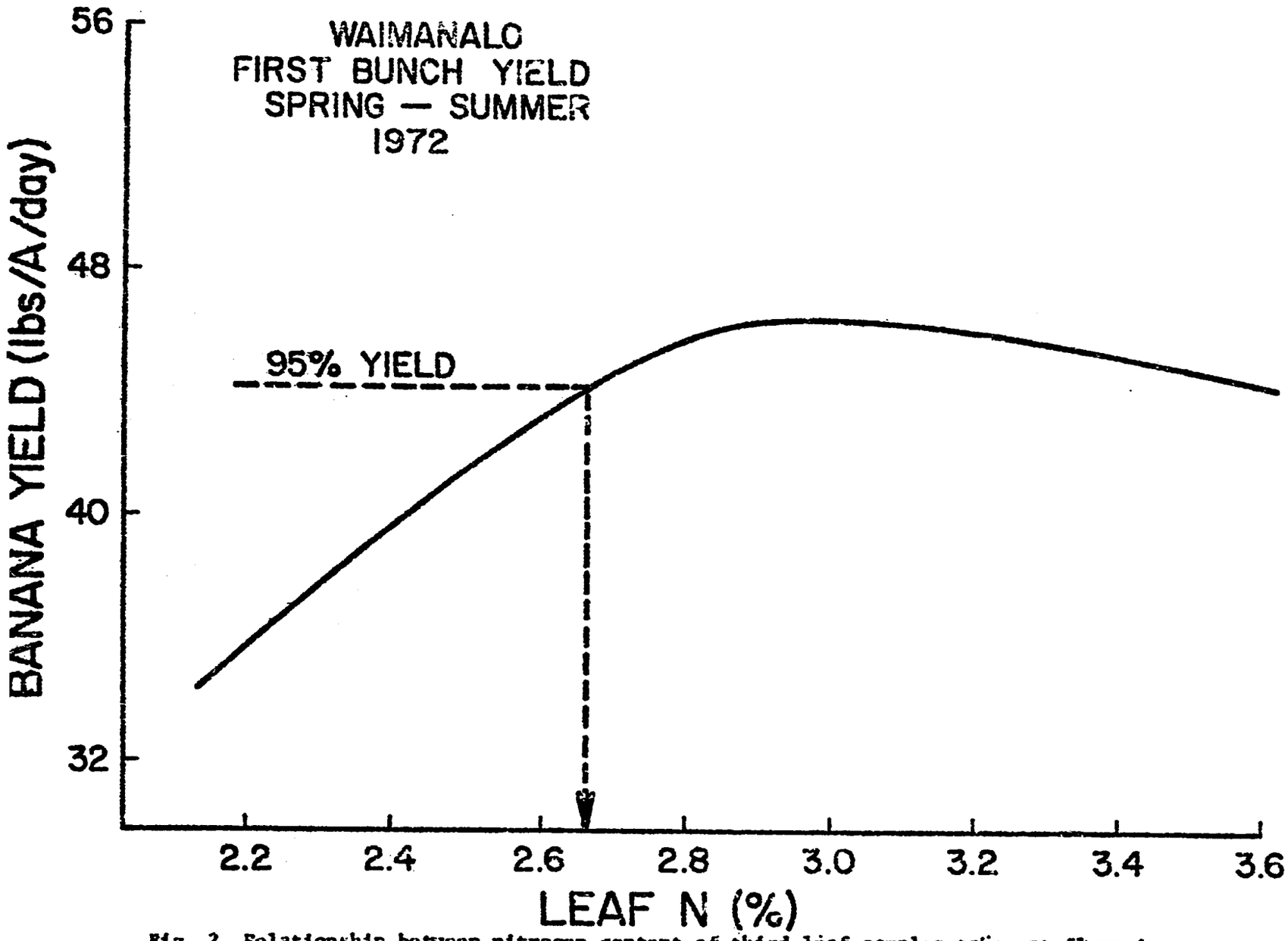

Fig. 2 Relationship between nitrogen content of third leaf samples taken at flowering and pounds per acre per day of bananas at harvest.

Table 1 Percent N in leaves of control plants. Nitrogen is deficient in blocks 1 to 4 recover 20 to 30 days after urea is added

	Leaf N % CONTROL PLANTS			
Plot	4/26	5/17	6/7	6/20
1	2.46	N added	2.40	2.67
2	2.54		2.98	2.95
3	2.64		2.73	2.61
4	2.48		2.52	2.66
5	3.83		3.76	
6	2.98		3.24	
7	3.36		3.50	
8	3.55		3.50	

Table 2 Percent K in leaves of control plants. K is deficient in blocks 5 to 8. Note partial recovery 20 days after K application

	Leaf K% CONTROL PLANTS		
Plot	4/26	5/17	6/7
1	3.41		3.87
2	3.66		3.38
3	3.26		4.29
4	3.41		4.64
5	2.69	K added	2.86
6	2.76		3.45
7	2.99		3.26
8	2.65		3.06

Table 3. Mean Weight, pounds per bunch of Williams hybrid bananas from various rates of Nitrogen (N), Potassium (K), and Phosphate (P) fertilizers at Waimanalo Research Station.[1/]

		Pounds per acre rates Urea applied													
		0		128		377		633		883		1133			
K level	KCl lb/acre	1 P_1	P_2	2 P_1	P_2	3 P_1	P_2	4 P_1	P_2	5 P_1	P_2	6 P_1	P_2	mean P_1	P_2
1	0	45.8	38.7	53.4	49.2	49.2	54.2	51.0	53.7	54.5	52.0	53.2	59.2	51.2	51.2
2	58	59.0	40.0	54.5	50.2	49.8	54.0	52.2	55.0	53.5	51.8	60.2	52.0	54.8	50.5
3	174	53.5	39.0	55.0	55.2	56.5	51.0	55.8	54.2	54.2	49.0	54.8	54.0	55.0	50.3
4	293	54.5	41.0	49.5	45.5	53.0	57.4	57.0	53.3	53.0	52.2	57.5	61.7	54.2	51.8
5	406	62.0	53.0	55.0	44.5	50.2	54.5	54.5	55.2	55.8	57.0	54.6	58.5	55.3	53.8
6	522	50.2	38.8	55.2	48.8	53.3	61.6	52.0	53.2	52.2	52.2	57.0	54.8	53.3	51.5
7	638	53.8	31.0	52.5	46.5	49.5	56.8	53.8	55.8	49.0	54.0	47.6	57.0	51.0	50.2
8	766	55.8	44.7	62.8	48.5	61.1	52.2	56.5	53.0	52.8	56.0	47.8	52.0	56.2	51.0
mean		54.4	40.8	54.8	48.5	52.9	55.3	54.1	54.1	53.1	53.0	54.1	56.1	55.4	51.3

[1/] Means of 3 or 4 bunches, first bunch per mat only, harvested before August 26, 1972.

Table 4 Relation of Nitrogen application rates and plant density to total number of bunches shot[1/]

lbs/A Urea (N)	Density Low	Density High	9/22/72 Total
0	62	54	116
128	69	67	136
377	80	85	165
633	80	97	177
883	90	100	190
1138	75	95	170
Total	456	498	954

1/ Williams hybrid 56 weeks after planting

Table 5 Relation of Potash application rates and plant density to total number of bunches shot[1/]

lbs KCl	Density Low	Density High	9/22/72 Total
0	56	49	105
58	55	65	110
174	52	64	116
293	57	62	119
406	61	57	118
522	52	63	115
638	59	75	134
766	57	61	118
Total	449	496	905

1/ Williams hybrid 56 weeks after planting