

**SOIL FERTILITY
STUDIES
with
PICKLING
CUCUMBERS
in the
PIEDMONT AREA
of
ALABAMA**



AGRICULTURAL EXPERIMENT STATION/AUBURN UNIVERSITY
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Soil Fertility Studies with Pickling Cucumbers in the Piedmont Area of Alabama

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COMMERCIAL CUCUMBER PRODUCTION in Alabama has been characterized by family size operations with small acreages and low yields. Some 4,000 to 4,500 families in the State produce and sell pickling cucumbers from about 7,000 total acres. Gross return during 1968 and 1969 averaged about \$161 per acre, according to a survey by Auburn University Cooperative Extension Service.

Little fertilizer research on pickling cucumbers has been done in recent years, and none of the earlier work was on the Piedmont soils of Alabama. Fertilizer studies conducted in 1934 and 1935 on recently cleared land at the Gulf Coast Substation, Fairhope, Alabama (5), showed that maximum yields of cucumbers resulted from use of 36 pounds of N, 50 pounds of P, and 30 pounds of K per acre. At Auburn in 1951-53 (6), maximum yields on Alaga sand were produced from 800 pounds per acre of an 8-8-4 (N-P₂O₅-K₂O) fertilizer without irrigation and 1,200 pounds per acre when irrigation was added.

Anderson (1) in the late 1930's obtained maximum yields of cucumbers in Mississippi from 32 pounds of N, 56 pounds of P, and 26 pounds of K on old land and from 64 pounds of N, 42 pounds of P, and no K on recently cleared land. Results obtained by Cooper and Watts in Arkansas (2) in 1934 indicated that P was most often the limiting nutrient for pickling cucumbers, followed by N. Reynolds (4) was unable to observe any differential responses to various rates of fertilizer applied to pickling cucumbers grown on a fertile Maryland soil. In studies with rates of N, P, and K, McCollum and Miller at North Carolina (3) found few of the yield differences were assignable to treatment effects at the 95 per cent level of probability; however, positive trends were

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evident from increments of N and K up to 80 pounds and from P up to 63 pounds per acre. The objective of the Auburn University Agricultural Experiment Station research reported here was to determine effects of rates of N, P, and K on pickling cucumber production in the Piedmont area.

EXPERIMENTAL PROCEDURES

The Alabama experiment reported here was conducted for 4 years (1968-72) on the Piedmont Substation at Camp Hill. The first year's test was on an eroded slope area (Area 1) having a soil test pH of 5.0, medium P, and low K and Mg, Table 1. For the 1969 test, a bottomland area (Area 2) with a soil test pH of 5.2, medium P, high K, and high Mg was used. In 1970, 1971, and 1972, the same plots were used each year on a relatively level, potentially productive soil area. This area (Area 3) had a soil test pH of 5.7, medium P, high to very high K, and high Ca and Mg. Dry weather in 1970 caused a poor stand and the crop was abandoned.

TABLE 1. SOIL TEST VALUES FOR DIFFERENT AREAS PLANTED TO PICKLING CUCUMBERS

Field area and year	pH	Soil content ¹ per acre			
		P	K	Ca	Mg
		<i>Lb.</i>	<i>Lb.</i>	<i>Lb.</i>	<i>Lb.</i>
1—1968.....	5.0	27-(M)	64-(L)	-----	36-(L)
2—1969.....	5.2	28-(M)	212-(H)	-----	90-(H)
3—1970.....	5.7	42-(M)	357-(H)	2,000-(H)	120-(H)
3—1971.....	6.1	45-(M)	400-(VH)	1,056-(H)	120-(H)

¹ Fertility level: low (L), medium (M), high (H), and very high (VH).

The experimental design was a randomized complete block with four replications. Fertilizer treatments for 1968 and 1969 consisted of four rates of N, P, and K, Table 2. In 1971 and 1972 a check treatment with no N, P, or K was also included, Table 3. All fertilizer except half of N was applied before planting. The mixed pre-plant fertilizer was broadcast and incorporated, except for 300 pounds that was applied and incorporated in the row. The remaining half of N was applied as a sidedress after thinning plants. In 1968, 1969, and 1970 (the year the crop was abandoned), 1.5 tons of lime was applied before planting the cucumber crop.

The variety Southern Cross was used and plantings were made during late April each year. Plants were thinned to 2 per hill spaced 18 inches apart in rows 3.5 feet wide (16,592 plants per

TABLE 2. YIELDS OF MARKETABLE GRADES OF PICKLING CUCUMBERS FROM RATES OF NITROGEN, PHOSPHORUS, AND POTASSIUM, AREA 1 (1968) AND AREA 2 (1969)

Fertilizer, lb. per acre ¹ N-P-K	Marketable yields per acre by grades							
	Area 1				Area 2			
	No. 1	No. 2	No. 3	Total	No. 1	No. 2	No. 3	Total
	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>
Rates of N test								
40- 78-100	18.5	28.0	23.7	70.2 c ²	30.8	94.5	53.3	178.6 b
80- 78-100	25.8	43.8	39.9	108.7ab	37.4	102.8	49.4	189.6 b
120- 78-100	29.8	44.4	46.3	120.5a	38.5	109.6	53.8	201.9 b
160- 78-100	25.3	40.7	40.3	106.3ab	39.8	105.7	60.0	205.5 b
Rates of P test								
120- 26-100	22.3	41.6	34.7	98.6abc	37.4	113.4	58.0	208.8 b
120- 52-100	25.7	46.1	41.4	113.2ab	29.4	90.1	81.5	201.0 b
120- 78-100	29.8	44.4	46.3	120.5a	38.5	109.6	53.8	201.9 b
120-130-100	27.5	42.0	31.4	100.9ab	47.3	125.0	99.0	271.3a
Rates of K test								
120- 78- 33	25.0	40.2	38.8	104.0ab	36.1	97.2	60.1	193.4 b
120- 78- 66	21.8	37.1	25.8	84.7 bc	44.6	106.3	73.3	224.2ab
120- 78-100	29.8	44.4	46.3	120.5a	38.0	109.6	53.8	201.9 b
120- 78-133	26.8	46.1	46.9	119.8a	38.6	97.8	69.1	205.5 b

¹ Rates of 26, 52, 78, and 130 pounds of P per acre are, respectively, equivalent to 60, 120, 180, and 300 pounds per acre of P₂O₅.
² Rates of 33, 66, 100, and 133 pounds of K are, respectively, equivalent to 40, 80, 120, and 160 pounds per acre of K₂O.

³ Figures followed by the same letter do not differ significantly at the .05 level by Duncan's Multiple Range Test.

TABLE 3. YIELDS OF MARKETABLE GRADES OF PICKLING CUCUMBERS FROM RATES OF NITROGEN, PHOSPHORUS, AND POTASSIUM, AREA 3, 1971-72

Fertilizer, lb. per acre ¹ N-P-K	Marketable yields per acre by grades								
	1971				1972				2-yr. av. total
	No. 1	No. 2	No. 3	Total	No. 1	No. 2	No. 3	Total	
<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	<i>Cwt.</i>	
Rates of N test									
0- 78-100.....	76.1	150.6	118.2	344.8 b ²	33.6	96.8	89.9	220.3 bc	282.5 bcde
40- 78-100.....	65.7	147.4	119.0	332.1 b	30.8	98.3	105.1	234.2 bc	283.2 bcde
80- 78-100.....	66.7	144.3	123.6	334.6 b	33.3	92.3	107.1	232.7 bc	283.7 bcde
120- 78-100.....	72.1	163.6	129.0	364.7ab	34.4	105.9	95.5	235.8 bc	300.2abc
160- 78-100.....	73.4	157.5	111.1	342.0 b	35.0	97.4	97.1	229.5 bc	285.7 bcd
Rates of P test									
120- 0-100.....	74.8	157.6	81.9	314.3 b	31.5	83.7	52.5	167.7 d	241.0 e
120- 26-100.....	76.2	141.2	114.1	331.5 b	34.6	94.4	86.5	215.6 bc	273.5 cde
120- 52-100.....	68.9	134.1	123.1	326.2 b	37.2	110.0	92.3	239.5 bc	282.7 bcde
120- 78-100.....	72.1	163.6	129.0	364.7ab	34.4	105.9	95.5	235.8 bc	300.2abc
120-130-100.....	98.4	170.4	145.8	414.6a	40.7	107.8	99.2	247.7 b	331.2a
Rates of K test									
120- 78- 0.....	67.9	132.4	103.0	303.3 b	30.7	97.3	71.4	199.4 cd	251.3 de
120- 78- 33.....	77.9	157.9	117.0	352.9 b	35.8	106.7	97.7	240.2 bc	296.5abc
120- 78- 66.....	67.5	145.0	141.8	354.3 b	43.4	132.5	114.5	290.4a	322.4ab
120- 78-100.....	72.1	163.6	129.0	364.7ab	34.4	105.9	95.5	235.8 bc	300.2abc
120- 78-133.....	74.4	135.4	150.6	360.5ab	43.1	113.3	82.6	239.0 bc	299.7abc

¹ Rates of 26, 52, 78, and 130 pounds of P per acre are, respectively, equivalent to 60, 120, 180, and 300 pounds per acre of P₂O₅. Rates of 33, 66, 100, and 133 pounds of K are, respectively, equivalent to 40, 80, 120, and 160 pounds per acre of K₂O.

² Figures followed by the same letter do not differ significantly at the .05 level by Duncan's Multiple Range Test.

acre). The plots were 3 rows wide and 12 feet long. Harvest records were obtained from the middle row.

For rootknot nematode control, nemagon at the rate of $\frac{1}{2}$ gallon or the equivalent in 10 per cent granules was applied pre-plant. Naptalam (Alanap) at the rate of 4 pounds per acre was applied post-plant over the area for weed control.

RESULTS AND DISCUSSION

Cucumbers were harvested three times each week to obtain small size fruit for grades 1, 2, and 3. The harvest period each year ranged from 4 to 5 weeks. Yields recorded are by marketable grades, tables 2 and 3. The total marketable yield generally will be discussed.

Yields for 1968 and 1969 (Table 2). The lowest total marketable yield in 1968 was from the lowest rate of N, 40 pounds per acre. There was a significant response to 80 pounds of N over 40 pounds, but no response to higher rates. There were no significant responses to P or K.

During the second year, 1969, the test was conducted on a more productive, bottomland soil (Area 2) that was not eroded as was Area 1. The result was that overall yields were larger than in 1968. Although there were no marked yield differences from different rates of N, there was a trend for increasing yields as rate was increased up to 120 pounds.

Marketable yields of pickling cucumbers from 26, 52, and 78 pounds of P per acre were the same. With the 130-pound P rate, however, yields were higher than from any of the lower rates.

There were no marked differences in yields from the different rates of K.

Yields for 1971 and 1972 (Table 3). Yields were higher in 1971 than in any of the other years. This may have been the result of the more favorable rainfall distribution, Table 4. No weekly period during the 1971 growing season was without rainfall, while in other years there were weeks of little or no rainfall. Smaller differences from treatments occurred in 1971 as compared with 1972, but trends were similar. Since the test was on the same plots in Area 3 both years, the 2-year average will be discussed.

This area was probably the most potentially productive of the three areas used and yields were higher than on 1968 and 1969 test locations. Application of fertilizer N had no effect on yield. Rather large differences did occur from application of fertilizer

TABLE 4. RAINFALL DURING GROWING SEASON, PIEDMONT SUBSTATION, 1968-72

Period of month ¹	Rainfall by monthly periods			
	1968	1969	1971	1972
	Inches	Inches	Inches	Inches
April, 3rd quarter.....	0	3.59	0.09	0.52
April, 4th quarter.....	2.30	0	3.97	.44
May, 1st quarter.....	.31	.20	1.03	1.00
May, 2nd quarter.....	1.85	3.35	1.85	1.93
May, 3rd quarter.....	.23	1.89	.50	.73
May, 4th quarter.....	.37	.16	.70	.10
June, 1st quarter.....	0	0	.37	0
June, 2nd quarter.....	0	0	.72	.14
June, 3rd quarter.....	.76	1.79	1.01	3.04
June, 4th quarter.....	.15	.81	.51	2.91
July, 1st quarter.....	1.10	0	.88	1.22
July, 2nd quarter.....	2.68	1.50	2.07	0
July, 3rd quarter.....	.10	.57	2.54	3.97
July, 4th quarter.....	1.88	.78	4.29	2.64
August, 1st quarter.....	.69	1.89	1.19	1.14
August, 2nd quarter.....	3.35	.39	.86	.70
TOTAL.....	15.77	16.92	22.58	20.48

¹ Periods represent one-fourth of month (7 to 8 days each).

P, however, with a trend toward increased yield with each increase in rate up to the highest, 130 pounds P per acre.

The response to fertilizer K was not as great as from P, although applications of 33 pounds or more increased yield over the 0 rate of K. This increase is unusual since the soil was already very high in soil test K. There may have been some benefit from direct application of a small amount of K fertilizer in the row. If so, this benefit could not be measured in the 1968 and 1969 tests because there was no check plot without K.

Growth characteristics. One reason for small yield differences from various treatments might be attributed to the characteristics of the cucumber plant to set and develop fruit to pickle size. The cucumber vine will continue to produce female flowers and set fruit but all fruit will not continue to grow at the same time. The set fruit has a tendency to be depressed in growth while the oldest fruit is enlarging. Thus, production is depressed unless the enlarging cucumber is harvested at the No. 1, 2, or 3 stage of growth. Ware *et al.* (6) showed by tagging female blooms in plots receiving normal harvesting that some cucumbers reached No. 3 size within 3 to 4 days after bloom and others required 15 to 20 days. Tagged fruit on a vine with a larger fruit failed to grow until the larger fruit was removed in harvest.

Nutrients removed by harvested crop. Samples from one harvest of pickling cucumbers in 1968 were analyzed for N, P, and

K. There was little difference in the percentages of N, P, and K for the different fertilizer treatments, Table 5. The values were projected to the total harvest weights for the season to indicate total removal of N, P, and K in the harvested product. Since there was little difference in percentages, the differences in total removal would be a reflection of yield differences caused by treatment. Total yields given in Table 5 are larger than those of tables 2 and 3 because culls also were harvested and included in calculating removal.

TABLE 5. TOTAL YIELD, PER CENT DRY WEIGHT, PER CENT N, P, AND K OF FRESH WEIGHT AND AMOUNTS OF N, P, AND K REMOVED BY HARVEST OF PICKLING CUCUMBERS, AREA 1, 1968

Fertilizer, lb. per acre N-P-K	Total yield/ acre	Dry weight	Fresh weight of fruit			Amount per acre removed by fruit		
			N	P	K	N	P	K
	<i>Lb.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Pct.</i>	<i>Lb.</i>	<i>Lb.</i>	<i>Lb.</i>
Rates of N test								
40- 78-100.....	8,623	4.58	0.17	0.027	0.34	14.67	2.33	29.32
80- 78-100.....	13,414	4.48	.18	.028	.36	24.15	3.76	48.29
120- 78-100.....	14,344	4.58	.19	.025	.32	27.25	3.59	45.90
160- 78-100.....	12,740	4.64	.19	.024	.32	24.21	3.06	40.78
Rates of P test								
120- 26-100.....	11,345	4.40	.18	.025	.34	20.42	2.84	38.57
120- 52-100.....	13,487	4.49	.18	.025	.33	24.28	3.37	44.51
120-130-100.....	12,159	4.39	.16	.023	.32	19.45	2.80	38.73
Rates of K test								
120- 78- 33.....	12,727	4.50	.17	.020	.28	21.64	2.55	35.64
120- 78- 66.....	9,728	4.59	.18	.024	.31	17.51	2.33	30.16
120- 78-133.....	14,333	4.56	.18	.023	.33	25.80	3.30	47.30

Leaf samples were taken during the early harvest of cucumbers in 1968 and during the late harvest period in 1972 for determination of percentage N, P, K, Ca, and Mg in the leaves, Table 6. There was little effect of fertilizer treatment on percentages of the elements contained in the leaves, except in the case of K where applied K increased its content in plant leaves.

TABLE 6. RATES OF N, P, AND K ON LEVELS OF N, P, K, Ca, AND Mg IN CUCUMBER LEAVES

Fertilizer, lb. per acre N-P-K	Per cent content in dry leaves during harvest period ¹														
	Nitrogen			Phosphorus			Potassium			Calcium			Magnesium		
	1968	1972	Av.	1968	1972	Av.	1968	1972	Av.	1968	1972	Av.	1968	1972	Av.
Rates of N test															
0- 78-100	---	4.13	---	---	0.32	---	---	4.07	---	---	0.38	---	---	1.27	---
40- 78-100	4.20	4.11	4.15	0.40	.30	0.35	5.63	4.20	4.91	0.30	.37	0.34	0.70	1.24	0.97
80- 78-100	4.54	4.40	4.47	.39	.31	.35	5.19	4.24	4.72	.37	.39	.38	.84	1.43	1.14
120- 78-100	4.34	4.61	4.48	.43	.34	.38	6.01	4.48	5.25	.35	.38	.37	.78	1.22	1.00
160- 78-100	4.39	4.57	4.48	.41	.34	.37	5.56	4.15	4.86	.37	.38	.38	.71	1.30	1.01
Rates of P test															
120- 0-100	---	4.50	---	---	.30	---	---	4.48	---	---	.38	---	---	1.22	---
120- 26-100	4.49	4.69	4.59	.46	.32	.39	6.02	4.69	5.36	.37	.30	.34	.75	1.06	.91
120- 52-100	4.60	4.37	4.49	.39	.32	.36	5.45	4.62	5.54	.37	.42	.39	.91	1.26	1.09
120-130-100	4.55	4.41	4.48	.39	.33	.36	6.14	4.82	5.48	.29	.41	.35	.85	1.16	1.01
Rates of K test															
120- 78- 0	---	4.33	---	---	.32	---	---	3.88	---	---	.39	---	---	1.28	---
120- 78- 33	4.59	4.55	4.57	.38	.35	.37	3.83	4.89	4.36	.33	.36	.34	1.05	1.16	1.11
120- 78- 66	4.24	4.66	4.45	.31	.39	.34	4.40	4.41	4.41	.34	.34	.34	1.00	1.17	1.09
120- 78-133	4.00	4.45	4.23	.29	.37	.33	5.56	4.74	5.15	.40	.34	.37	1.02	1.13	1.08

¹ Leaf samples consisted of recent mature size leaves taken during early harvest of cucumbers in 1968 and during late harvest in 1972, 41 and 81 days after planting, respectively.

SUMMARY

Effect of rates of N, P, and K on production of pickling cucumbers was studied for 4 years in field experiments at the Piedmont Substation, Camp Hill.

Response to fertilizer N was variable, depending on the soil area. The largest benefit was on the eroded, upland soil where 80 pounds of N appeared to be the best rate. On a more productive, bottomland soil only a trend toward increased yields from fertilizer N was observed, while on a highly productive area there was no benefit.

Phosphorous was the most limiting of the three fertilizer elements on these soils which were medium in soil test P. Fertilizer P either gave large increases in yield or showed trends for increases in yield with increasing rates at all of the locations. The largest increases were on the most potentially productive soil area.

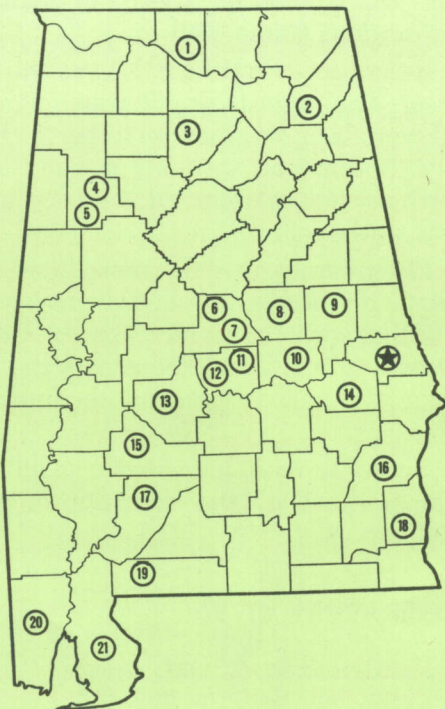
Response to K indicated a yield increase only from small applications. With the exception of Area 1, all soils showed high soil test K.

LITERATURE CITED

- (1) ANDERSON, W. S. 1941. Growing Cucumbers for Pickling in Mississippi. Miss. Agr. Exp. Sta. Bull. 355.
- (2) COOPER, J. R. AND V. M. WATTS. 1934. Fertilizer for Cucumbers. Ark. Agr. Exp. Sta. 46th Ann. Rpt. Bull. 312:45-46.
- (3) McCOLLUM, R. E. AND C. H. MILLER. 1971. Yield, Nutrient Uptake, and Nutrient Removal by Pickling Cucumbers. Proc. Amer. Soc. Hort. Sci. 96(1):42-45.
- (4) REYNOLDS, C. W. 1954. Studies with Cucumbers for Pickling. Ph.D. Thesis. Univ. of Md. 153 pages.
- (5) WARE, L. M. AND W. A. JOHNSON. 1949. Fertilizer with Vegetable Crops on Representative Soils of Alabama. Auburn Univ. (Ala.) Agr. Exp. Sta. Bull. 269.
- (6) -----, C. L. ISBELL, HUBERT HARRIS, AND W. A. JOHNSON. 1953. Studies with Pickling Cucumbers in Alabama. Auburn Univ. (Ala.) Agr. Exp. Sta. Cir. 114.

AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

Main Agricultural Experiment Station, Auburn

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.