Factors Affecting APPLE YIELDS

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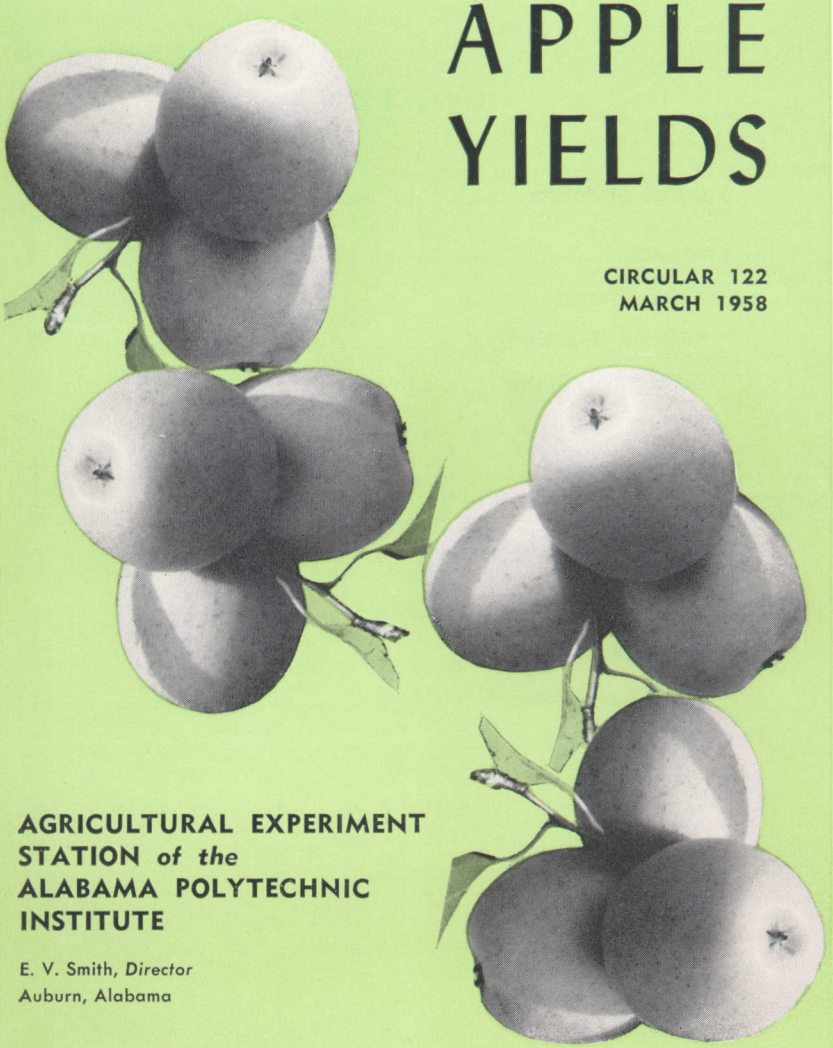

AGRICULTURAL EXPERIMENT STATION *of the* ALABAMA POLYTECHNIC INSTITUTE

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Factors Affecting
APPLE YIELDS

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COMMERCIAL APPLE GROWING in Alabama is an old agricultural enterprise. Production is centered primarily in central and northern sections of the State. The apple-growing area is comprised largely of mountain chains that afford favorable conditions for fruit production. Nights are relatively cool during the growing season in this region that has elevations of 600 to 2,400 feet. Production is primarily for fresh market sales. Most varieties bloom reasonably early and mature a crop of fruit by mid- or late summer. There is much less competition for fresh market apples during this period, and prices are usually good for high-quality fruit.

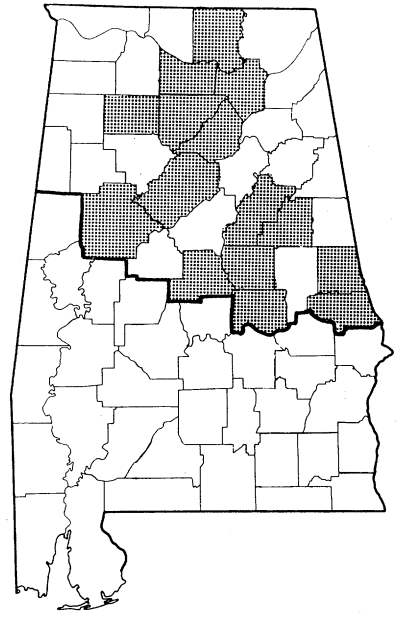
Apple production has contributed substantially to farm income in northern Alabama in past years, but recently yields of marketable fruits have decreased to the extent that this enterprise now contributes little income except in a few counties. In 1945, Alabama produced 498,039 bushels of apples with market value of $1,146,341.[1] By 1954 production dropped to 166,448 bushels with a market value of $382,835. Tree population in 1954 was 167,794 bearing trees and 57,927 nonbearing trees. Neglect and improper management practices have contributed greatly to declining production in this State.

The study reported in this circular was made in the summer of 1955 (1) to determine factors associated with and affecting apple yields, (2) to stimulate the interest of fruit growers in managing their orchards to better advantage, and (3) to provide information for increasing production of marketable fruit.

[1] Taken from U.S. Census of Agriculture, 1954.

METHOD of STUDY

Thirty-four orchards in 15 counties were selected from a list of apple growers.[2] Orchards with fewer than 100 trees were not included. Factors studied were: Yield, size, age, tree spacing, and varieties; soils, fertilizer, and cultural practices; location of orchard site with respect to direction of rows and slope; and prevalence of disease and insect damage, and methods of control. Data were obtained from personal interviews and records of growers.



Shaded counties were included in the survey. Area north of black line is apple growing region of the State.

Soil and leaf samples were taken from each orchard for chemical analyses. Soil samples consisted of a composite of borings (0 to 6 inches) taken at random throughout each orchard. Leaf samples included 100 most recently matured leaves of each major variety from current twig growth.

FINDINGS

Yield Classes

Data from the 34 orchards studied are arranged into five different yield classes on the basis of production per tree, Table 1.

TABLE 1. NUMBER AND PER CENT OF ORCHARDS IN EACH YIELD CLASS

Yield class	Average age of trees	Average yield per tree	Orchards	
			Number	Per cent
	Yr.	*Bu.*	*No.*	*Pct.*
A	11	5+	4	12
B	16	4+	2	6
C	11	3+	4	12
D	7[1]	2+	9	26
E	17	0–1+	15	44
TOTAL			34	100

[1] One orchard was 35 years old and was not included in average.

[2] The list was furnished by the API Agricultural Extension Service.

Classes are separated by a yield difference of 1 bushel per tree.

Thirty per cent of the orchards studied were in the top 3 yield classes, while 70 per cent were in the 2 lowest. Of the 34 orchards studied, 10 were producing more than 3 bushels of apples per tree, which is low for commercial production. Forty-four per cent of orchards yielded less than 2 bushels per tree and 12 per cent had a yield of more than 5 bushels.

Cultural Practices

Soil Management. Many soil management practices were used in the orchards studied, Table 2. Sixty-eight per cent had a summer cover crop of either sericea lespedeza or native vegetation, mainly annual weeds and grasses. Twelve orchards were planted to a winter cover crop of legumes or a legume-nonlegume mixture. Intercropping was practiced in nine orchards with corn, cotton, soybeans, watermelons, and home or market gardens being the principal crops grown. One orchard was intercropped in the 3 highest yield classes, while in the 2 lowest 8 were intercropped. Grazing was more prevalent in the higher yield classes than was intercropping.

Native vegetation was the main summer crop found in the orchards studied, Table 3. Eight orchards had sericea lespedeza as a cover crop, whereas two were clean cultivated. Apparently sericea lespedeza had little effect on yield, because there was little difference in the per cent sericea in each yield class. Since native vegetation was used as a summer cover crop, shallow or "trashy" cultivation was used on level or gently sloping land to reduce competition for moisture and nutrients.

Winter legumes and legume-nonlegume mixtures were grown in 12 orchards, Table 4. Crimson clover and vetch were the two

TABLE 2. SOIL MANAGEMENT PRACTICES IN ALL ORCHARDS

Treatment	Orchards receiving different treatments	
	Number	*Per cent*
Total orchards studied	34	100
Permanent sod (sericea lespedeza)	8	24
Summer cover crop (native vegetation)	23	44
Winter cover crop (winter legume or winter legume-nonlegume mixture)	12	35
Intercropped	9	26
Clean culture	2	6
Grazed by:		
hogs	5	15
cows	5	15
chickens	1	3

TABLE 3. RELATIONSHIP OF YIELD CLASS TO SUMMER SOIL MANAGEMENT

Yield class	Orchards	Management practice					
		Sericea lespedeza		Clean culture		Native vegetation	
	No.	*No.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*
A	4	1	25	0	0	3	75
B	2[1]	0	0	0	0	1	50
C	4	1	25	1	25	2	50
D	9[2]	2	22	0	0	3	33
E	15[2]	4	23	1	7	6	40

[1] One orchard had soybeans as a summer cover crop.
[2] Four orchards were intercropped.

TABLE 4. RELATIONSHIP OF YIELD CLASS TO WINTER SOIL MANAGEMENT

Yield class	Orchards	Orchards with winter legume or legume-nonlegume mixture	
	No.	*No.*	*Pct.*
A	4	3	75
B	2	0	0
C	4	1	25
D	9	2	22
E	15	6	40

leading legumes being planted, while rye and ryegrass were the leading nonlegumes. Others included manganese bur clover, white Dutch clover, fescue, and orchardgrass. A higher percentage of orchards in yield class A had a winter legume than any other yield class.

Fertilization. Fertilizer applications ranged from 103 pounds per acre in the lowest yield class to 1,095 pounds per acre in the highest class. In the four highest yield classes, all growers applied fertilizer either to the trees or to the cover crop, but only 20 per cent of the growers in yield class E applied fertilizer, Table 5.

There was a direct relationship between yields and the amount of N, P_2O_5, and K_2O applied, Table 6. Nitrogen ranged from 4 pounds per acre in the lowest yield class to 53 pounds in the high-

TABLE 5. RELATIONSHIP OF YIELD TO AMOUNT OF FERTILIZER APPLIED PER ACRE

Yield class	Orchards	Average amount of fertilizer applied per acre			Orchards receiving fertilizer	
		To trees	To cover crops	Total		
	No.	*Lb.*	*Lb.*	*Lb.*	*No.*	*Pct.*
A	4	583	512	1,095	4	100
B	2	570	325	895	2	100
C	4	495	300	795	4	100
D	9	302	54	356	9	100
E	15	13	90	103	3	20

TABLE 6. RELATIONSHIP OF YIELD TO THE KIND OF FERTILIZER APPLIED

Yield class	Orchards	Kind and amount of fertilizer applied per acre			
		Total amount	N	P_2O_5	K_2O
	No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
A	4	1,095	53	113	86
B	2	895	34	86	50
C	4	795	33	75	93
D	9	356	28	15	10
E	15	103	4	11	11

est; P_2O_5 ranged from 11 to 113 pounds; and K_2O ranged from 11 pounds in the lowest yield class to 93 pounds in class C, with an average of 86 pounds applied in class A.

Nutritional Status

Chemical analyses were made on leaf samples from each orchard to establish relationship between fertilizer rates and nutrient-element content of orchard trees. There was a direct relationship between leaf content and the amount of fertilizer applied per acre. On a dry weight basis, nitrogen ranged from 2.02 per cent in the leaves of the highest yielding orchards to 1.75 for the lowest; phosphorus, 0.15 to 0.11 per cent; potassium, 1.59 to 1.42 per cent; calcium, 1.12 to 0.92 per cent; and magnesium, 0.43 to 0.32 per cent. Boron was deficient in several orchards, while iron appeared to be adequate. As the rates of nitrogen fertilizer were increased, leaf nitrogen also increased. Average leaf nitrogen was low in all yield classes except A. There were individual orchards in every yield class that had a nitrogen content of 2.0 per cent or more, which is considered optimum.[3]

TABLE 7. NUTRITIONAL STATUS OF THE 34 ORCHARDS STUDIED IN RELATION TO NATIONAL AVERAGES FOR HEALTHY, VIGOROUS APPLE TREES

Element	Dry weight content		Samples below	
	National average	Alabama average	National average	Alabama average
	Pct.	*Pct.*	*Pct.*	*Pct.*
Nitrogen	2.36	1.85	100.0	48.5
Phosphorus	0.23	0.13	100.0	53.0
Potassium	1.64	1.50	65.0	51.5
Calcium	1.61	0.99	98.5	50.0
Magnesium	0.43	0.36	80.0	53.0
	p.p.m.	*p.p.m.*		
Boron	37	63	44.0	60.0
Iron	134	245	1.5	58.0
Sodium	----	345	----	35.0

[3] Magness, J. R. Fertilization: Both Ground and Foliage Methods Discussed. Eastern Fruit Grower. 13:8-10, 18, 20-22, 24, 26. 1950.

When compared with the national average nutritional status[4] for healthy, vigorous apple trees, the 34 orchards studied were below national averages for the major elements analyzed, Table 7. Boron and iron levels were higher than those for national averages.

Soils

Orchards in this study were located on four general soil textures, Table 8. A higher per cent of the orchards were located on sandy loam soil. Clay loam was the next largest soil type. Five orchards were located on gravelly sandy loam or clay. There was no evidence that soils influenced yields.

TABLE 8. RELATIONSHIP OF YIELD CLASS TO SOIL TEXTURE

Yield class	Orchards	Orchards in each soil texture			
		Sandy loam	Clay loam	Gravelly sandy loam	Clay
	No.	*No.*	*No.*	*No.*	*No.*
A	4	3	0	1	0
B	2	1	1	0	0
C	4	4	0	0	0
D	9	3	3	1	2
E	15	10	4	0	1
TOTAL	34	21	8	2	3

Tree Spacings

In a majority of the 34 orchards, trees were spaced 30 to 40 feet, Table 9. Spacings were usually 35 by 35 or 40 by 40 feet. Trees were spaced 30 to 40 feet in approximately 68 per cent of the orchards. Thirty-two per cent had 20 to 30 feet between trees. In some of these closely spaced orchards, crowding was beginning

TABLE 9. RELATIONSHIP OF YIELD CLASS TO TREE SPACING

Yield class	Orchards	Orchards with different tree spacings	
		20 to 30 feet	30 to 40 feet
	No.	*No.*	*No.*
A	4	2	2
B	2	0	2
C	4	2	2
D	9	3	6
E	15	4	11
TOTAL	34	11	23

[4] Kenworthy, A. L. Composition of Delicious Apple Leaves from Several States. Paper No. 25. Presented to 51st Ann. Meeting Amer. Soc. Hort. Sci., Gainesville, Fla. 1954.

to be a serious problem in movement of equipment and trees needed thinning. However, production per acre was greater in the closely spaced orchards when trees were young.

Varieties

There were 26 different varieties in the 34 orchards, ranging in maturity from very early to very late. The three leading varieties were Golden Delicious, Delicious, and Winesap, Table 10. Variety alone was not a limiting factor in production, but arrangement of varieties for good pollination was not favorable in some orchards. One orchard had a solid block of 650 Winesap trees with a few Golden Delicious trees scattered around the edges. Other factors being equal, this arrangement could limit yield of apples. Promising new varieties for Alabama, such as Red Gold, St. Clair, Martha, Summer Champion, Atha, and Gridel, were planted in a few orchards. Of the 12,110 trees surveyed, 34 per

These 20-year-old Winesap trees bloom regularly but do not produce apples because of poor pollination.

TABLE 10. VARIETY AND NUMBER OF TREES IN EACH YIELD CLASS

Yield class	Varieties								Per cent of total trees
	Golden Delicious		Delicious		Winesap		Other		
	No.	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*	*No.*	*Pct.*	
A	725	27	1,015	37	300	11	669	25	22
B	275	40	285	42	75	11	52	7	6
C	260	17	362	24	50	3	865	56	13
D	1,493	42	1,045	29	0	0	1,047	29	29.5
E	1,374	38	945	26	895	25	378	11	29.5
TOTAL	4,127	34	3,652	30	1,320	11	3,011	25	100

cent were Golden Delicious, 30 per cent Delicious, 11 per cent Winesap, and 25 per cent other varieties.

Diseases and Insects

Farmers growing early maturing varieties and following a good spray program were keeping losses to a minimum. Growers in the four highest yield classes sprayed more often than those in the lowest yield class, which is reflected in the per cent damage caused by major diseases and insects, Table 11. Bitter rot, *Glomorella cingulata,* and fire blight, *Erwinia Amylovora,* are the most serious diseases of apples in Alabama. Fire blight damage was

TABLE 11. RELATIONSHIP OF YIELD TO PREVALENCE OF DISEASES AND INSECTS

Yield class	Orchards	Disease and insect damage				
		Fire blight	Apple scab	Bitter rot	Codling moth	San Jose scale
	No.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
A	4	12	25	15	18	20
B	2	15	25	25	20	20
C	4	16	30	32	24	32
D	9	17	10	20	20	20
E	15	23	45	59	51	53

lowest in yield class A. Several of these growers were using antibiotics for control of the blight organism. Damage due to San Jose scale and codling moth were approximately the same. Other diseases and insects causing damage to apples in Alabama included a root rot organism, round- and flat-headed apple tree borers, and leaf hoppers.

All growers in the top three yield classes owned spray machines, Table 12, and followed a regular spray schedule. Some growers in yield class E owned spray machines but had not used them in the past few years. Two of the growers with young orchards did not own spray machines but were using hand sprayers.

TABLE 12. RELATIONSHIP OF YIELD TO SPRAY MACHINES OWNED

Yield class	Orchards	Growers owning spray machines		Growers using spray machines
	No.	*No.*	*Pct.*	*No.*
A	4	4	100	4
B	2	2	100	2
C	4	4	100	4
D	9	7	77	7[1]
E	15	11	73	4
TOTAL	34	28	83	22

[1] Two sprayers were hand-type.

RECOMMENDATIONS *for* INCREASING PRODUCTION

Fertilization

One and one-half pounds of 8-8-8 fertilizer per tree per year of age, not exceeding 30 pounds per mature tree, gives good results. When orchards are in sod or non-legume winter cover crop, 30 additional pounds of nitrogen per acre is needed. A total of 500 to 600 pounds of 0-14-14 or 0-16-8 fertilizer should result in good growth of legume cover crops in the fall. Soil tests made every 2 or 3 years will determine lime needs.

Disease and Insect Control

A good spray schedule begins in the dormant season and continues until harvest. Spray applications every 7 to 10 days during the fruiting season ensure good pest control. It is important that sprays be applied on time and of the correct mixture for the material being used. Good control of insects and diseases were obtained at the North Alabama Horticulture Substation by using regular applications of 2 pounds of 50 per cent Captan and 2 pounds of 15 per cent wettable parathion per 100 gallons water.

A sod of sericea lespedeza, winter legume, or legume-nonlegume mixture is recommended for mature orchards. Tree and cover crop competition can be reduced by mowing regularly during summer. Cover crops are left on the ground to serve as a mulch. Additional mulch of oat or wheat straw placed around the trees prevents excessive growth of cover crop under trees and conserves soil moisture, especially when trees are young. Annual pruning will remove diseased wood, train the tree, and increase the amount of marketable fruit. Fruit thinning when a heavy crop is set increases fruit size, reduces limb breakage, and reduces biennial bearing.

New Plantings

Sandy loam soil with a topsoil of 12 to 18 inches and a well-drained clay subsoil is preferred for new apple plantings. It is best to locate the orchard on a northern slope with good air drainage. It is desirable that the slope not be too steep for movement of machinery through the orchard. Trees can be spaced 28 by 28 feet if thinned. Where land will permit, a 35- by 35- or 40- by 40-foot spacing is more desirable. Trees may be planted on the contour or square depending on the topography of site. Based on variety tests and surveys, varieties recommended for new plantings are red strains of Delicious (Richard and Starking), Golden

Delicious, Winesap, Saint Clair, Atha, and Summer Champion. No variety should be more than two rows from a pollinating variety. Young orchards may be intercropped for the first few years provided crops are not planted closer than 6 feet to the tree row. It is a good practice to cultivate and mulch young trees.