highlights

of agricultural research

Volume 24, No. 1

Agricultural Experiment Station
R. Dennis Rouse, Director

Spring 1977

Auburn University
Auburn, Alabama

DIRECTOR'S COMMENTS

SOMETIMES we are reluctant to remember how rapidly the world in which we live is changing, but it is important to keep this in mind as we plan for the future in producing food and fiber. As I write this, we are in the throes of the coldest winter in years with resultant frozen waterways, energy shortages closing schools and factories, and snow as far south as West Palm Beach, Florida – all making the news along with the inauguration of a Georgia peanut farmer as President of the United States.

R. DENNIS ROUSE

The cold has stopped growth of winter grazing, and hay is short; cattlemen are in an all too familiar dilemma. If he sells his hungry cattle at depressed prices, he takes a beating; if he buys scarce feed, he has more investment in his cattle than he is likely to get back.

On another front, this Nation is concerned about drought conditions in its "bread basket." One factor, not common to Alabama, contributing to consistently high grain crop yields in the Central United States is soil characteristics that enable crops to draw on a reservoir of subsoil moisture, offsetting inadequate rainfall during the growing season. This reservoir is dry and the 1977 crops will depend on the rainfall during the growing season just as Alabama farmers have to do every year. Thus, one important insurance against a short crop does not exist for 1977.

I cite these situations because they provide an opportunity to again make a point that so many and so much depend on each American farmer; the difference between a surplus and a shortage of food is very small. Every farmer knows only too well the impact of a surplus or shortage on price in the marketplace.

Agricultural research came into being in an effort to overcome shortages, improve preservation and distribution, and to thus minimize the uncertainty in supply. Agricultural research should be everyone's concern because in this century it has been a major contributor to increasing agricultural productivity. Worldwide, there is still a food shortage and many countries do not have purchasing power and transportation to provide imported food for the masses of people. Therefore, in the marketplace, the cycles move from surplus to shortage. Farmers must find still more positive ways to ensure against problems associated with these cycles, such as diversification of crops and cropping systems, diversification of animal enterprises and production systems, on-farm storage, marketing cooperatives, use of marketing systems, and more effective use of science and technology.

The Alabama Agricultural Experiment Station is dedicated to advancing agricultural science and technology in this changing world. It is the publicly-supported agricultural research organization upon which every person in Alabama must depend to carry on the kind of research program that will assist the 70,000 Alabama producers of food and fiber. It costs money to carry on a program of research but studies show that every dollar invested in publicly-supported agricultural research in recent years has returned $36: Surely this is a good investment.

It is a necessary investment if we expect to maintain a high standard of living as a State and Nation. Your Alabama Agricultural Experiment Station is inadequately funded to support the research program needed. Our scientists are giving an excellent account of what is provided them. However, they cannot do all that the consumers need for them to do without additional support.

may we introduce . . .

Dr. Kirby L. Hays, head, department of Zoology-Entomology. Following the retirement of Dr. F. S. Arant in June 1975, Dr. Hays took over the leadership role in the Department.

Born in Cullman County, Dr. Hays graduated from Arab High School. He earned a B.S. degree from Auburn in 1948. Following a stint with the army during the Korean conflict and two years working for the USDA, Dr. Hays returned to Auburn to earn an M.S. degree in 1954. After working his way through the University of Michigan, serving as a graduate research assistant, Dr. Hays was awarded the Ph.D. in 1958.

Since returning to Auburn in February 1957 as an assistant professor in the Department of Zoology-Entomology, Dr. Hays has taught 14 different courses and has been major professor for 15 doctoral students and 31 masters students. He has worked on 12 research projects at Auburn and has authored or co-authored 68 research publications and numerous professional papers.

Among his many honors are memberships in Phi Kappa Phi, Gamma Sigma Delta, Phi Sigma, and Sigma Xi honoraries and is a former Chairman on the Auburn University Faculty and Senate.

HIGHLIGHTS of Agricultural Research

SPRING 1977 VOL. 24, NO. 1

A quarterly report of research published by the Agricultural Experiment Station of Auburn University, Auburn, Alabama.

R. DENNIS ROUSE ..... *Director*
STANLEY P. WILSON ..... *Associate Director*
CHAS. F. SIMMONS ..... *Assistant Director*
T. E. CORLEY ..... *Assistant Director*
E. L. MCGRAW ..... *Editor*
R. E. STEVENSON ..... *Associate Editor*
ROY ROBERSON ..... *Assistant Editor*

Editorial Advisory Committee: STANLEY P. WILSON; J. D. HARPER, *Associate Professor of Entomology;* WALTER D. KELLEY, *Assistant Professor of Botany and Microbiology;* EARL L. WIGGINS, *Professor of Animal and Dairy Sciences,* AND E. L. MCGRAW.

Auburn University is an equal opportunity employer.

ON THE COVER. Application of foliar fungicides in peanut leafspot test at the Wiregrass Substation, see related story page 4.

Yuchi arrowleaf clover (left) and Gulfcoast cantaloupe (right) are Auburn releases that utilized plant introductions.

FOREIGN PLANT IMMIGRANTS MAKE GOOD ALABAMA CITIZENS

C. S. HOVELAND, *Department of Agronomy and Soils*

All agricultural crops and most ornamental plants currently grown in Alabama are immigrants from other parts of the world. Not a single crop now cultivated here is native to the State. The American Indian first brought corn, a native of Mexico, to Alabama. Since then, private individuals, the U.S. Department of Agriculture, and state agricultural experiment stations have brought in new plants from abroad.

In the late 1940's a cooperative federal-state program was launched for introduction and evaluation of plants for agricultural uses and for the preservation of valuable germplasm. Trained plant explorers are sent to various parts of the world to collect potentially promising plants. Seed or vegetative material is brought to the United States for further increase. Four regional plant introduction stations (Geneva, New York; Ames, Iowa; Pullman, Washington; and Experiment, Georgia) grow and maintain these plants. Seed or vegetative materials are available to researchers in each state.

Some plant introductions can be used without modification. Others may require further breeding to obtain adapted varieties useful for food, forage, fiber, or landscaping. However, most of the introductions are used in breeding programs as sources of valuable characters. Frequently an introduced plant is found worthless except for one desirable character, such as resistance to diseases, nematodes, or insects. Thousands of plants may be screened by the plant breeder to find a desired characteristic. The plant breeder must then transfer this desirable character to another variety. This often is a long, tedious undertaking, but it can pay good dividends.

Virtually all of the new and improved crop and ornamental varieties grown in Alabama are derived partially or entirely from plants introduced through the federal-state program. They have been released by state experiment stations, USDA, Soil Conservation Service, or commercial breeders.

Several field and horticultural crop varieties utilizing plant introductions have been released by Alabama researchers (Auburn University Agricultural Experiment Station, Soil Conservation Service, and Northrup-King Co.). These include Yuchi arrowleaf clover, ball clover, Nova vetch, Millex-23 pearlmillet, Atkinson tomato, Greenleaf tabasco pepper, and Gulfcoast and Chilton cantaloupe varieties.

Plant introductions are contributing a great deal to improved production of tomatoes, cucumbers, cowpeas, peppers, watermelons, cantaloupes, and plums in Alabama. Forage improvement programs are utilizing plant introductions to develop better adapted varieties of tall fescue, phalaris, birdsfoot trefoil, orchardgrass, vetch, alfalfa, sericea, and annual clovers. New varieties are expected to be released in the near future from several of these breeding programs.

Recent plant explorers in Peru, southern Brazil, southern Africa, New Guinea, and eastern and southern Africa have brought back native plants that are already being used in breeding programs. Other collecting expeditions are planned for southern Russia, central America, southeast Asia, and the eastern Mediterranean area. It is imperative to collect native or local crop plants in these areas as soon as possible. Human populations are expanding rapidly in many of these areas, causing more marginal land to be put into food production. As a result, valuable native plants are being lost. Many of these should be added to our store of plant introductions as a source of material for plant breeders to use in improving crop plants. Future improvement that can provide plants with disease, nematode, and insect resistance and other desirable traits may depend on characteristics present in these native plant introductions. Foreign plant immigrants are the lifeblood of future variety breeding programs.

PEANUT FOLIAR FUNGICIDES: Relationships Between Leafspot Control and Kernel Quality

J. M. HAMMOND, P. A. BACKMAN, J. A. LYLE
Department of Botany and Microbiology

THE EFFECTIVENESS of foliar fungicides for control of peanut leafspot caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deight, was evaluated from 1971-1974 at the Auburn University Agricultural Experiment Station.

Benlate, Bravo, Duter, and Kocide 404-S were applied at recommended rates by conventional ground sprayer at 14-day intervals. Leafspot severity was rated by determining percent defoliation and infection. All fungicide-treated plots had less defoliation and infection than the untreated control plots, Table 1. Kernel quality was determined using Federal-State Inspection Service procedures. Plots sprayed with Bravo had slightly better quality kernels than those from any other fungicide treatment. However, kernels harvested from the untreated control plots had significantly better quality than those from the Bravo treatment. Kernels harvested from the Benlate and Kocide 404-S treatments were slightly inferior in quality compared to the Bravo treatment, although not significantly. Kernels from the Duter treated plots were significantly inferior in quality to those from plots treated with other fungicides, Table 2.

These data indicated two possible mechanisms for kernel quality effects: (1) maintenance of a complete foliar canopy and (2) a direct toxic action effect of the fungicide on soil-borne fungi. The maintenance of a relatively complete foliar canopy made at least three major changes in the ecology of soil-borne fungi: (1) fewer leaves were lost to the soil surface to serve as an organic food source; (2) pesticides were filtered from the soil surface by an "umbrella effect" of the canopy; and (3) an altered subcanopy environment was created which may be stimulatory to certain pathogenic soil-borne fungi.

TABLE 1. DEFOLIATION LEVEL (%) OF *Arachis hypogaea* L. CAUSED BY *Cercospora* SP. IN LEAFSPOT CONTROL TEST, 1971-1974

Treatment	1971	1972	1973	1974	$\bar{x}$*
Control	79.9 a	53.0 a	44.0 a	64.4 c	59.3 a
Bravo 54 F	43.4 c	6.4 d	5.8 bc	15.0 d	22.7 c
Benlate 50 WP	24.8 d	5.3 d	6.1 bc	55.1 b	17.5 d
Duter 47 WP	50.2 bc	18.5 b	12.4 b	33.1 d	30.3 b
Kocide 404-S (27 + 15) F	56.3 b	12.1 c	2.6 c	18.7 d	20.7 cd

Values within columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.
* Weighted mean.

TABLE 2. KERNEL QUALITY VALUES (DOLLAR VALUE/TON) OBTAINED FROM PEANUT (*Arachis hypogaea* L.) LEAFSPOT CONTROL TEST, 1971-1974

Treatment	Rate/ acre	1971	1972	1973	1974	$\bar{x}$*
Control	0.00	304.90	296.73	298.60	409.43	327.03 a
Bravo 54 F	1.5 pt.	301.40	290.92	277.21	398.45	316.56 b
Benlate 50WP	6.0 oz.	297.32	281.66	268.55	395.68	310.64 b
Duter 47WP	6.0 oz.	298.87	284.79	239.68	367.85	298.33 c
Kocide 404-S (27 + 15) F	2.0 qt.	301.15	299.27	291.63	386.38	312.94 b

Values within columns followed by the same letter are not significant at the 5% level of probability using Duncan's Multiple Range Test.
* Weighted mean.

TABLE 3. YIELD (LB./ACRE), QUALITY ($/TON), AND VALUE PER ACRE (DOLLAR) OBTAINED FROM PEANUT (*Arachis hypogaea* L.) LEAFSPOT CONTROL TESTS, 1971-1974

Treatment	Rate/ acre	Yield/ acre	Value/ ton	Value/ acre
		Lb.	*Dol.*	*Dol.*
Control	0.00	2,558 d	327.03 a	418.27 d
Bravo 54 F	1.5 pt.	3,889 a	316.56 b	615.55 a
Benlate 50WP	6.0 oz.	3,286 c	310.64 b	510.38 c
Duter 47WP	6.0 oz.	3,433 bc	298.33 c	512.08 b
Kocide 404-S (27 + 15) F	2.0 qt.	3,592 b	312.94 b	561.88 b

Values within columns followed by the same letter are not significant at the 5% level of probability using Duncan's New Multiple Range Test.

If a direct toxic action of the fungicide on soil-borne fungi was responsible for the deterioration of kernel quality, one would expect kernels of superior quality from plots where the fungicide exhibited toxicity to the pathogenic fungi, but little or no effect on the natural antagonists. Inferior quality kernels would be found in plots where fungicides exhibited toxicity to the antagonists, but with little or no effect on the quality-deteriorating pathogens. Several observations support this hypothesis. First, similar levels of defoliation were obtained when Benlate, Duter, and Kocide 404-S were used to control leafspot, Table 1. However, use of Duter resulted in significantly inferior kernels when compared to the other two fungicides giving similar leafspot control, Table 2. Secondly, when values for kernel quality were examined, the control had a significantly higher dollar value per ton than any of the fungicide treatments.

If peanuts from the control plots are of better quality and a true inverse relationship exists between leaf maintenance and kernel quality, than Benlate or Kocide-treated plots (which had the least defoliation) should have the most inferior kernel quality of the fungicide-treated plots. Peanuts from Benlate and Kocide-treated plots were not significantly inferior in quality to peanuts from Bravo-treated plots.

A third indication that a toxic action of the fungicides altered the geocarposphere was observed with the fungicide Benlate. Benlate was extremely effective as a leafspot control fungicide in 1971 and 1972. However, during 1973 the pathogen developed resistance to this fungicide and during the 1974 season disease severity in Benlate-treated plots was nearly equal to that of the control, Table 1. Comparisons of quality data for Benlate-treated plots over the 4-year period showed no improvement in kernel quality as defoliation levels increased, Table 2. While not conclusive, these observations indicate that a direct toxic effect of a fungicide on a natural antagonist (or pathogen) is more important to kernel quality than the degree of leaf maintenance and the canopy, although they are interrelated.

It is important to realize that even though regular fungicide treatments for control of leafspot result in inferior quality peanut kernels, the tremendous yield increase resulting from the use of these fungicides dictates their continued use in the southeast, Table 3.

Alfalfa for the Deep South: Shortcomings and Potentials

R. L. HAALAND and C. S. HOVELAND, *Department of Agronomy and Soils*

DON'T GIVE UP on alfalfa. Even though it currently contributes little to the forage economy of the lower Southeastern United States, it still has potential for production in the Deep South.

The yield potential of alfalfa in Alabama is good for a short period. First-year production amounted to about 5 tons of dry matter per acre in tests at the three Auburn University Agricultural Experiment Station locations listed in the table. But the problem is in persistence. Whereas alfalfa stands last for 4 to 6 years in the northern United States, only 2 years of production can be expected in Alabama, Figure 1. Other alfalfa problems in the South include pathogens, management, and seed supply.

ALFALFA FORAGE DRY MATTER YIELDS AT THREE ALABAMA LOCATIONS, PER ACRE YIELD, BY YEAR OF PRODUCTION

Variety	Tallassee PBU		Brewton Field		Wiregrass Sub.	
	First year	Second year	First year	Second year	First year	Second year
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Florida 66	9,500	5,000	9,500	7,500	11,500	8,000
Buffalo	7,000	0	7,000	5,500	0	0

The warm, humid environment of the Southeast favors a severe plant and soil pathogen complex that includes leaf and stem fungi, parasitic nematodes, and root rotting fungi. This multiple pest complex weakens stands, which results in severe weed infestation and poor forage yield in the third year of production. Although the alfalfa weevil is a common pest, there are several labeled chemicals that can control it. Other pathogens are being battled through breeding programs developing resistant varieties.

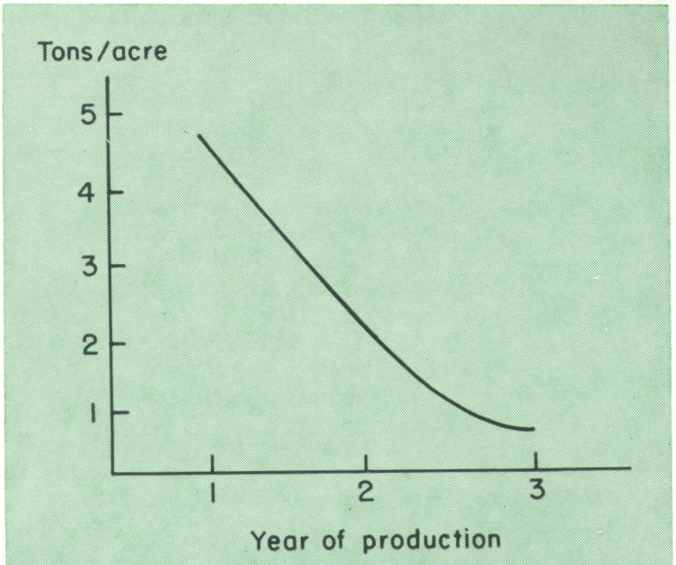


FIG. 1. Rapid decrease of alfalfa forage production illustrates short life of this crop in Alabama.

FIG. 2. Alfalfa selection nursery at Plant Breeding Unit, Tallassee.

Alfalfa is a high quality forage if properly managed. If not harvested at the proper time, however, forage quality deteriorates rapidly. Alabama's humid environment makes it difficult to harvest alfalfa for best quality forage. Producers with silos can overcome part of this problem. Forage can be cut at the proper time and stored in the silo if too wet to bale or cure in the field.

Short supply of well adapted varieties has been a problem of alfalfa producers throughout the Southeast. This reflects, in part, the lack of breeding programs in the Deep South. The variety Florida 66 is the best adapted variety for the Deep South, but it is not available yet. This variety is being screened in Arizona for resistance to the spotted aphid so adequate supplies of seed can be produced in the good seed producing areas of the West.

An alfalfa breeding program has been initiated at the Agricultural Experiment Station. Over 20,000 plants representing 100 different genetic lines are being tested for pathogen resistance and various quality attributes, Figure 2. New varieties from commercial and public sources are being evaluated at several Alabama locations to determine if any are adapted to this region.

Alfalfa should not be written off in the Deep South. There is a good possibility that more persistent varieties can be bred, varieties that will maintain good forage yields for at least 3 years. Once the potential for alfalfa forage production is demonstrated, commercial interest will increase and seed supplies will become more plentiful. In the meantime, such commercial varieties as Gladiator, Weevlcheck, and Apollo are available and will produce quality forage for at least 2 years.

WHAT HAS HAPPENED TO COTTON YIELDS?

GALE A. BUCHANAN, J. T. COPE, JR., and WILEY JOHNSON
Department of Agronomy and Soils
FLOYD GILLILAND, *Department of Zoology-Entomology*

COTTON YIELDS have been severely limited in the major cotton-growing region of Alabama in recent years. There are indications that yields have reached a plateau or have actually decreased in some cotton producing areas in the United States.

Although there has been speculation regarding the general trend of lowered yields, there is no simple explanation for the reduced production in these years. Several factors have been suggested that could account for lowered production. In addition to lower-than-normal temperatures and planting late-maturing varieties, the factors most often mentioned include, (1) late planting, (2) plant bugs, (3) herbicides, and (4) nitrogen fertilizer. To study these factors and their interactions on cotton, an experiment was initiated at the Tennessee Valley Substation in 1976 that included a herbicide treatment, nitrogen variable, plant bug control, and time of planting.

The experiment was put on a Decatur clay loam, which is typical of many soils used for cotton production in northern Alabama. Each of the treatments was included alone and in all possible combinations. The entire experiment was cultivated and hand-weeded to ensure that weeds would not interfere with the growth of cotton. Adverse conditions, including a cold, wet spring and a summer drought, limited top yields to about 1,700 lb. of seed cotton per acre.

Date of Planting

Planting date has a major effect on many aspects of cotton production. Adverse growing conditions in the early spring can cause poor germination and slow growth, hampering the establishment of a vigorous stand. Later plantings are often more easily established but are usually later in fruiting and maturity and thereby more susceptible to freeze injury before all bolls are opened. In this study, two planting dates were chosen. "Early" planting represented the earliest possible planting (April 6, 1976) – as soon as fear of frost was past – and "late" planting, which was 3 weeks later. In contrast to what has usually been observed with regard to planting date and yield of cotton, there were no advantages with early planting in 1976.

Control of Plant Bugs

Plant bugs (*Lygus* spp.) have been suggested as contributing to lower cotton yields in recent years. Difficulty in early recognition and in establishing threshold levels that cause economic losses have complicated the problem with these pests. To evaluate the role of plant bug control on cotton yields, three treatments were included. These included no control, and initiation of plant bug control at 3 or 6 weeks after cotton squaring. Mustard was planted around the experiment to build up the population of plant bugs. At cotton squaring, the mustard was cut, thereby driving the bugs to the cotton.

All plots were treated in early June for an extremely heavy infestation of thrips. Additional applications in early and mid-July for plant bug control did not affect maturity or increase yields of early planted cotton. Multiple applications of insecticides for plant bug control on late planted cotton hastened maturity and increased yields about 200 lb. per acre of seed cotton.

Nitrogen

Nitrogen greatly influences cotton growth, development, and rate of maturity. Excessive nitrogen may produce excessive vegetative growth, delay fruiting, and increase difficulty of controlling insects and diseases. While the effect on maturity does not always reduce yield, delayed maturity may lower yield in case of an early frost. Nitrogen was included in the present study at 60, 90, and 120 lb. per acre. The 90 lb. rate increased yield about 100 lb. of seed cotton over 60 lb. rate. The 120 lb. rate produced the same as the 90 lb.

Herbicides

One series of treatments included no herbicides and a second series was treated with a common herbicide program. In this series, trifluralin (Treflan) was applied as a preplant incorporated treatment at 0.75 lb. per acre, fluometuron (Cotran) as a preemergence treatment at 2.0 lb., fluometuron + MSMA at 1.5 + 1.0 lb. as directed postemergence treatment and a final application of fluometuron at 1.0 lb. per acre as directed treatment at layby. This "total" herbicide program included only herbicides and rates that are presently labeled and recommended for weed control in cotton. The herbicide treatment significantly delayed maturity when compared to non-herbicide treated cotton.

An unexpected result was a decrease in total cotton yields on plots treated with herbicides as compared to cotton grown on comparable plots in which no herbicides were used. While these results are obviously preliminary, the effects of herbicides on cotton should be carefully assessed.

Giant Blackeye variety (left) and Auburn breeding line Ala. 562.3-1-2 (right) vary widely in growth habits and plant maturity characteristics.

Protein Content, Protein Quality, and Yield of Selected Cultivars of Southern Peas

D. R. STRENGTH, *Dept. of Animal and Dairy Sciences*
O. L. CHAMBLISS, *Department of Horticulture*

SOUTHERN PEAS aren't restricted to the Southern United States. They are eaten in most areas of the world and are a valuable source of protein.

Because of their potential for supplying needed world protein and their importance as a crop in the Southeast, Southern peas have received detailed study by Auburn University Agricultural Experiment Station. Introductions of Southern peas or cowpeas, *Vigna unguiculata*, from five continents[1] and selected cultivars (varieties) and Auburn breeding lines were evaluated.

Characteristics of the cultivars that influence their quality as a food crop were evaluated. Measured were yield, plant conformation, uniformity of harvest, disease and insect resistance, protein quality, and antinutritional compounds present in the seed.

The protein contents of more than 600 samples of cowpeas ranged from 17 to 33% crude protein (ambient moisture). Most samples ranged between 22 and 26% protein. Complete amino acid analyses of several cultivars showed that cystine and methionine were present in low amounts.

TABLE 1. YIELDS OF SELECTED CULTIVARS OF SOUTHERN PEAS

Cultivar and type	Yield per acre[1]	
	Pods	Shelled
	Lb.	*Lb.*
Once-over harvest		
Miss. Silver (crowder)	4,595	3,100
Ala. 963.8 (lady)	5,027	2,561
Ala. 562.3-1-2 (cream)	3,428	1,660
Giant Blackeye (blackeye)	4,004	1,895
Multi-harvest		
Miss. Silver (crowder)	5,999	3,319
Ala. 963.8 (lady)	5,355	2,613
Ala. 562.3-1-2 (cream)	5,108	2,474
Ala. 562.9-3-1-2 (cream)	5,170	2,071
Giant Blackeye (blackeye)	6,081	2,874

[1] Averages from 3-5 crops.

In feeding tests with rats, growth was poor when raw cowpea meal was fed. Growth was markedly improved by cooking (autoclaving) and supplementing with methionine and cystine. Adding cystine and methionine to raw cowpeas boosted growth by almost 40%. Cooking and supplementing with methionine alone or smaller amounts of methionine and cystine gave results equal to using casein (a good quality protein).

[1] Maintained at the Southern Regional Plant Introduction Station, Experiment, Georgia.

Cultivars and breeding lines analyzed were representative of the different types of varieties available, Table 1. With the exception of Giant Blackeye, maturity concentration and plant form are acceptable for commercial production and machine harvesting. Mississippi Silver is grown extensively for commercial production and is consistently high yielding. It is resistant to Fusarium and root knot nematodes, and tolerant to virus diseases.

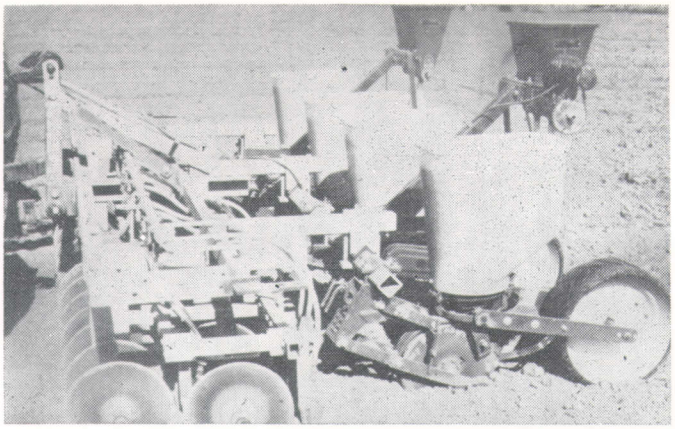
The "lady" type (Ala. 963.8) and the "cream" types (Ala. 562.3-1-2 and Ala. 562.9-3-1-2) are generally lower yielding. However, their excellent eating quality and flavor make them preferred over "crowder" types in some cases. Resistance to Cercospora leaf spot and cowpea curculio are added advantages for Ala. 963.8. Giant Blackeye produces a high yield when hand harvested over the season, but it is not satisfactory for machine harvesting.

An evaluation of several selected cultivars, Table 2, provided data on the protein efficiency ratio (PER). This is measured as grams of gain by rats per gram of protein eaten. Autoclaving improved gains on all cultivars by destroying antinutritional factors. For example, Giant Blackeye contains highest level of antitrypsin and gives most improvement on cooking. After cooking, Mississippi Silver and Ala. 963.8 gave relatively better growth than other varieties. This indicates a better balance of amino acids and this was confirmed by analysis.

TABLE 2. EVALUATION OF PROTEIN OF COWPEAS BY PROTEIN EFFICIENCY RATIO (PER) IN YOUNG RATS[1]

Cultivar	Protein content[2]	Protein consumed	Weight gain	Apparent PER	Adjusted PER
	Pct.	*Grams*	*Grams*		
Ala. 963.8	26.7	12.01	31.9	2.66	1.74
Ala. 963.8 (A)[3]		12.33	33.0	2.68	1.78
Ala. 562.3-1-2	23.1	10.91	23.9	2.25	1.52
Ala. 562.3-1-2 (A)		13.56	33.9	2.51	1.70
Ala. 562.9-3-1-2	25.3	12.08	24.5	2.01	1.30
Ala. 562.9-3-1-2 (A)		11.55	27.4	2.34	1.53
Miss. Silver	20.7	12.97	35.4	2.66	1.70
Miss. Silver (A)		13.86	47.4	3.41	2.18
Giant Blackeye	27.5	12.31	17.6	1.43	.97
Giant Blackeye (A)		12.66	29.5	2.33	1.57
Casein (controls)		---	---	(3.6-3.8)	2.50

[1] Values represent two trials with 4 rats fed each diet, for total of 8 rats per treatment.
[2] Pea meal from dry peas, ambient moisture.
[3] Autoclaved 20 minutes at 15-lb. stream pressure.



Granular pesticide applicator attached to corn planter can be used to apply granular insecticide into the furrow at planting.

Soil Insect Pests of Corn

P. M. ESTES, *Department of Zoology-Entomology*

CORN IS INCREASING in importance as a cash crop on Alabama farms. Therefore, insects that damage the crop are receiving emphasis in research by Auburn University Agricultural Experiment Station.

Soil inhabiting insects are among the most damaging corn pests. These insects do much of their damage unnoticed because they attack the corn plant from below. Four of the important soil insects are shown in the photographs.

The sugarcane beetle, wireworms, and billbugs occasionally cause severe damage to corn in Alabama. All three species feed on the roots and crown of the corn plant and cause stunting, excessive tillering, and lodging.

The southern corn rootworm is the most common soil insect pest of corn in the State. Damage is done by the larva feeding on the roots and stems of young seedlings. High population levels can reduce stands by 50% or more.

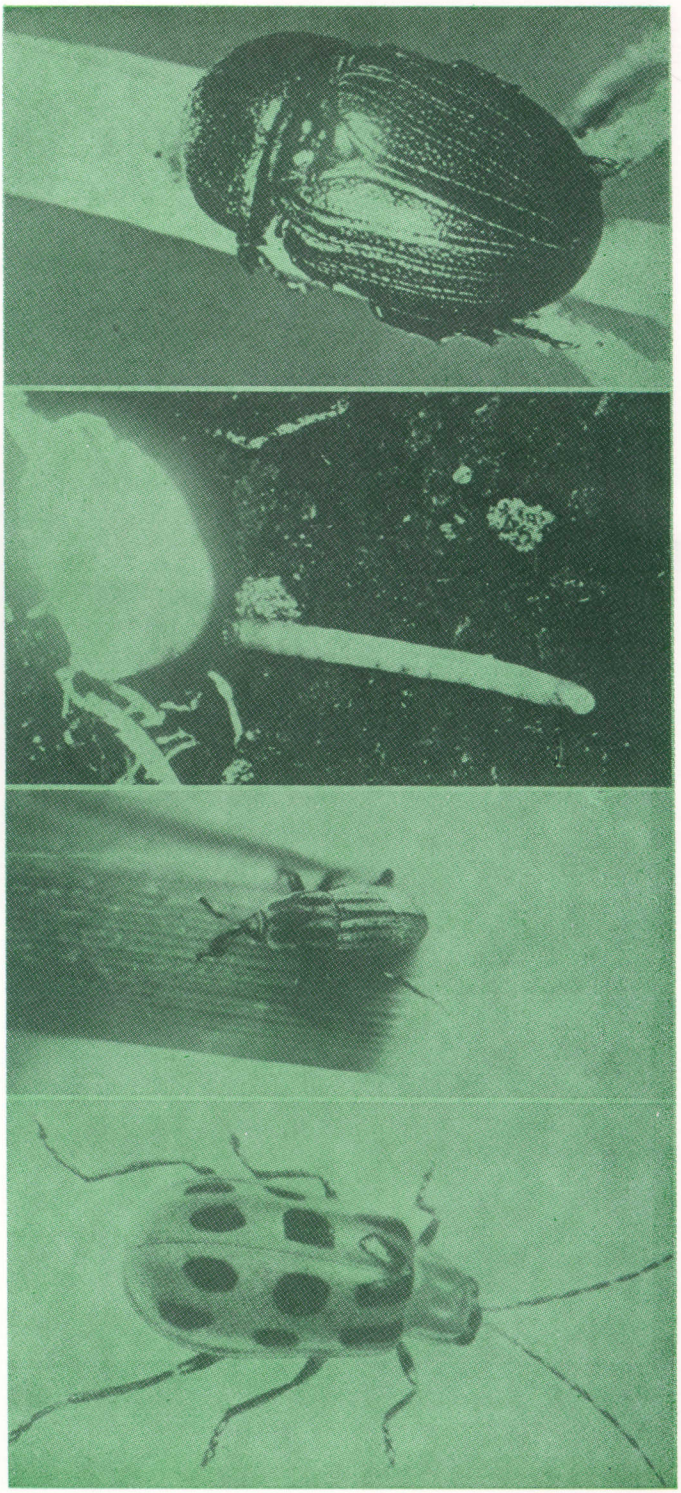
Control of soil insects to prevent damage is best achieved by cultural methods, such as rotation with non-host crops and early plowing of green manure crops. Chemical methods are also effective, as established by data in the table showing results of a test comparing insecticidal treatments on control of southern corn rootworm. The materials were applied as granules in the furrow at planting with equipment similar to that shown in the title photograph. It is noted that insecticides reduced the incidence of rootworm damage, but did not result in an increase in yield.

The data in the table reflect a perplexing situation: At what level of infestation are insecticide applications needed? Current research suggests that infestation levels greater than 10% of the stand are necessary before chemical application is warranted.

INSECTICIDE TEST FOR CONTROL OF SOUTHERN CORN ROOTWORM, GULF COAST SUBSTATION, 1976

Insecticide and rate, active/acre	Damaged plants[1]	Per acre yield
	Pct.	*Bu.*
Vydate, 2 lb.	4.0 a	151
Vydate, 4 lb.	2.3 a	136
BAY 92114, 1 lb.	2.1 a	154
Furadan, 1 lb.	1.5 a	154
Untreated check	11.8 b	142

[1] Means followed by the same letter are not different at the 5% level (Duncan's Test).



Four of the bothersome soil insect pests of corn, top to bottom, are: sugarcane beetle adult, wireworm larva in the soil, billbug adult on corn stalk, and southern corn rootworm adult.

FORAGE YIELDS OF REGRADED SURFACE MINES

D. H. WEINGARTNER and E. S. LYLE, *Department of Forestry*

BECAUSE OF a widespread desire to preserve the productivity of land and to protect environmental quality, reclamation of surface mined lands has received much attention over the last few years.

The Alabama Surface Mining Reclamation Act, which became law in 1975, requires that lands surface mined for coal be regraded, that the outer slopes be seeded with grasses and legumes to prevent erosion, and that the interior of the mine be returned to productive use. In 1974, the Auburn University Agricultural Experiment Station established experimental forage plots on three regraded surface mines in Bibb, Cullman, and Jefferson counties.

Spoil material at mines in Bibb and Cullman counties was composed mostly of sandstone, while the majority of spoil at the Jefferson County mine was shale. Soil tests, made by the Auburn University Soil Testing Laboratory, indicated the need for lime and fertilizer on all areas. These recommendations were followed when establishing fertilized plots, which were also limed according to recommendation. The pH of spoil materials was 3.8 for the Bibb County area, 4.8 for the Cullman County area, and 3.1 for the Jefferson County area. These pH values are typical for many of the mines in Alabama.

Fertilized and unfertilized (control) plots of three grasses and three legumes were seeded on each surface mine. The grasses were lovegrass, bermudagrass, and bahiagrass, for all mines. On mines in Bibb and Jefferson counties legumes seeded were Interstate sericea, Serala sericea, and Kobe lespedeza, while on the Cullman County mine Caricea sericea was substituted for Kobe. The plots were sampled after two growing seasons. Cover percentage was determined; and the forage harvested, oven-dried, and weighed. Yields in pounds per acre of seeded species were determined from the oven-dried samples; results are presented in the table.

Average grass production on the three mines was greatest with lovegrass, on both fertilized and control plots; bermuda, then bahiagrass, followed. For the two legume species planted on all three mines, production was greatest for Serala on both fertilized and control plots. Except on the Jefferson County area, where all legumes failed, Serala yields compared favorably with those reported by Donnelly[1] in his variety trials.

Analysis of the combined data from Bibb and Jefferson counties indicated that fertilization increased forage production of each species. This relationship was also found to hold for the Cullman County data. The combined analysis also showed that where a species performed better on one area it did so irrespective of treatment (fertilized or control), as shown in the table. Bahiagrass, Interstate, Serala, and Kobe all produced greater yields on the Bibb County mine than on the Jefferson County mine, while lovegrass and bermudagrass produced greater yields on the Jefferson County mine.

Grass cover on the mines ranged from 35% to 100% and legume cover from 12% to 100%. Percent cover was based upon all vegetation within the sample plots, whether sown or volunteer. Control plots of the two sericeas at the Jefferson County area had zero yield, but volunteer vegetation covered an average of 12% and 41% of the areas. As yield of seeded species increased, percent of cover by volunteer vegetation decreased.

Combined analysis of data from Bibb and Jefferson counties indicated that the Bibb County area produced more cover and that fertilization increased cover at both locations. Percent cover varied by species. On the Cullman County mine, bahiagrass produced more cover when fertilized.

The effectiveness of vegetation in preventing erosion is dependent on more than combined cover percentage and amount of vegetation produced. Growth habit of the plant is also important, particularly for the grasses. A solid canopy of lovegrass, which is a bunch grass, breaks up raindrops preventing splash erosion, but much of soil surface underneath is barren of vegetation and open to erosion by moving surface water. Sod forming grasses, such as bermuda, have more rooted stems per unit area, and provide more protection for the soil surface.

Following two growing seasons, overall grass and legume production were greatest for lovegrass and Serala sericea. However, maximum production varied by species on each mine. Application of lime and fertilizer was needed to maximize yield and cover. Percent cover varied by species on two of the mines, but not on the third. Sod forming grasses provide better erosion control than bunch type grasses.

DRY FORAGE YIELD, IN POUNDS PER ACRE, BY AREA AND TREATMENT

Species	Per acre yield by mine location					
	Bibb Co.		Jefferson Co.		Cullman Co.	
	F[1]	C	F	C	F	C
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Bahiagrass	2,009	200	413	107	4,030	1,094
Bermudagrass	603	200	2,766	1,768	6,097	1,465
Lovegrass	560	288	2,214	360	10,007	3,618
Interstate sericea	1,996	413	2	0	10,865	8,148
Serala sericea	5,285	2,687	187	0	9,134	7,174
Kobe lespedeza	3,056	640	80	1	---	---
Caricea sericea	---	---	---	---	11,426	5,683

[1] F—fertilized, C—control.

[1] Donnelly, E. D. 1963. Serala—A New Sericea Variety, Leaflet 70, Auburn Univ. (Ala.) Agr. Exp. Sta.

EXPORTS of MAJOR AGRICULTURAL COMMODITIES

MORRIS WHITE, *Department of Agricultural Economics and Rural Sociology*

AGRICULTURE in the United States affects everyone within the country and millions in foreign nations. Never have so many depended on so few producers for food and fiber.

Approximately 4.3 million workers on U.S. farms in 1975 were producing for 213 million people in this country and for increasing numbers elsewhere. A vast majority of people in the United States ate well in 1975 when nearly 1 out of 3 acres of cropland was devoted to production for export. During the past 5 years more than 90% of the increase in world trade of grain was accounted for by grain grown in this country. Also, approximately 20% of the dollars earned by the U.S. in trade with foreign countries in 1975 came from farm exports, which resulted in a trade surplus rather than a trade deficit.

Among the major farm commodities exported were cotton, food and feed grains, and soybeans. The commodity for which the volume of exports increased most in recent years was corn, Table 1. Comparatively, exports of cotton and wheat were greater than for corn and soybeans during years prior to 1966, which partly accounts for the greater relative increases shown for corn and soybeans after 1966. Provisions of the Food and Agricultural Act, which became effective in 1966, lowered the domestic support prices for these commodities to a level that made them competitive on the world market, and gave to farmers the opportunity to grow the crops of their choice.

The degree to which U.S. farmers and domestic users of farm commodities are affected by exports varies among commodities according to the proportion of annual production that is exported. In 1975, the proportion exported amounted to about 60% for wheat, 50% for soybeans, 32% for cotton, and 24% for corn. Through 1975, export markets were much more variable and uncertain than domestic markets – particularly those in countries that had centrally-planned economies. Market uncertainty adds to risks and creates problems in planning operations for producers, handlers, and processors. With a level of exports equal to that in 1975, some means will have to be devised to bring about more stability in the export markets for these commodities. Otherwise, serious disruptions and imbalances that will be difficult to control will occur in domestic markets at both the farm and retail levels.

TABLE 1. INDEX NUMBERS OF EXPORTS OF COTTON, WHEAT, CORN AND SOYBEANS, UNITED STATES, 1966-1975 (AV. OF 1960-65=100)

Year	Index, by commodity			
	Cotton	Wheat	Corn	Soybeans
1966	100	99	101	140
1967	90	100	131	143
1968	59	73	111	153
1969	59	82	127	232
1970	80	98	107	232
1971	69	84	165	223
1972	107	157	260	257
1973	123	154	257	289
1974	84	140	238	225
1975	75	162	331	281

Government-Financed Exports

Under provisions of the Agricultural Trade Development and Assistance Act (better known as Public Law 480) passed in 1954, Federal funds were used to aid in exporting farm commodities. Authority was provided for the sale of surplus agricultural commodities for foreign currency, shipments for emergency relief, barter for strategic material, and later, for long-term credit sales.

Commodities for which government financing has aided exports most were cotton and wheat, Table 2. Most aid prior to 1970 was in sales for foreign currency, but after 1970 major assistance was for long-term credit sales. Provisions for government-to-government donations and for donations through voluntary agencies were used most extensively for wheat and wheat products. Relatively less governmental assistance has been used for corn exports and none has been used for soybean exports since 1962.

The greatly increased foreign demand for U.S. produced commodities was due to several developments. Some countries shifted priorities and devoted more resources to improving diets of people within the country; the U.S. Government took action to move surpluses that had accumulated over a number of years; and the dollar was devalued and allowed to seek a level compatible with other currencies. As a result of these developments, earlier surpluses had virtually disappeared by 1973.

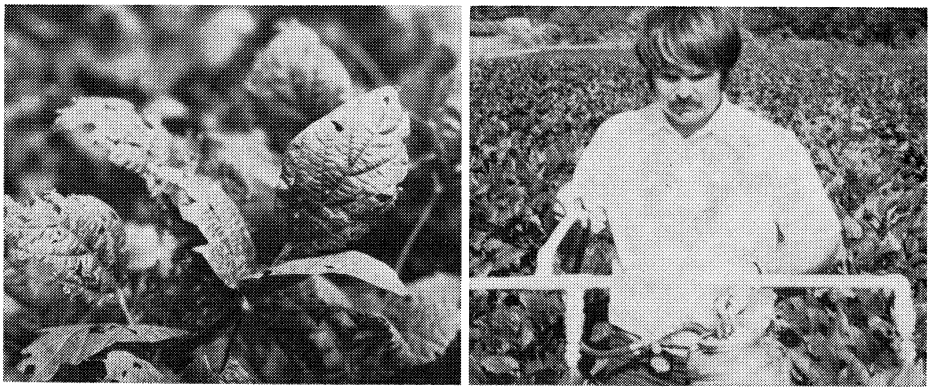
Foreign demand continued strong and provisions of the Agriculture and Consumer Protection Act of 1973 brought a change of emphasis in U.S. agriculture. The design was toward increasing production, not restricting it. U.S. farmers responded and exports increased. It is significant that a decreasing proportion of these commodities is exported under government-financed programs. Volumes for both domestic use and export must come from current production because the huge inventories that were stored for many years no longer exist. While expanded exports of these commodities will serve many desired purposes, it should be understood that as the proportion of production going to export markets increases, productions will become more dependent on a volatile, unpredictable market, and prices to U.S. consumers probably will be higher than they otherwise would be.

TABLE 2. PROPORTION OF THE TOTAL VALUE OF EXPORTS UNDER GOVERNMENT-FINANCED PROGRAMS, FOUR COMMODITIES, UNITED STATES, 1960-74

Year	Commodity			
	Cotton	Wheat	Corn	Soybeans
	Pct.	*Pct.*	*Pct.*	*Pct.*
1960	24	73	20	5
1961	26	68	26	3
1962	33	77	12	2
1963	21	59	12	0
1964	27	81	7	0
1965	28	81	8	0
1966	32	66	5	0
1967	31	49	9	0
1968	37	59	7	0
1969	25	48	3	0
1970	38	36	4	0
1971	21	27	4	0
1972	18	32	5	0
1973	15	11	3	0
1974	3	4	1	0

FOLIAR FERTILIZATION of SOYBEANS in ALABAMA

FRED ADAMS, *Department of Agronomy and Soils*



Soybean leaves damaged by foliar-applied fertilizer at left and foliar fertilizer being applied at right.

When Iowa State University agronomist Dr. John Hanway reported an increase of up to 23 bu. per acre of soybeans by using foliar fertilizer, farmers throughout the nation looked forward to increasing their soybean production.

Further experiments by the Auburn Agricultural Experiment Station and other universities across the country, however, show no significant differences in yield with foliar fertilization. In fact, the amount of rainfall during the pod-set and fill stage was the most influential factor at any given location.

Foliar Fertilization Does Not Replace Soil Applied

Foliar fertilization was not intended to replace, but was to be supplementary to soil-applied phosphorus and potassium fertilizers before planting. As the pods began to fill, foliar fertilizer was applied at 10 to 14-day intervals until beans were mature. It was hand sprayed at per acre rates of 25 lb. of nitrogen (N), 6 lb. of phosphorus (P_2O_5), 10 lb. of potassium (K_2O), and 1.5 lb. sulfur (S) at each application.

In cooperation with the Agricultural Experiment Station project, the Tennessee Valley Authority provided the experimental foliar fertilizer. The fertilizer, 10-2-4-4.0-0.6, was manufactured by the TVA's National Fertilizer Development Center at Muscle Shoals, Alabama.

Experiments Conducted

Six of the experiments were conducted in farmers' fields in north Alabama, one at the E. V. Smith Research Center, two at the Plant Breeding Unit in Tallassee, and two at the Wiregrass Substation.

Two experiments suffered from an extended drought and yielded only 18 bu. per acre. Two that did not suffer from drought yielded 50 bu per acre; the others yielded between 25 and 40 bu. Foliar fertilization did not increase yield in any of these cases.

Sites with the lowest average yield had less than 9 in. of rain from the time the plants started blooming until maturity. Sites with the highest yields had more evenly distributed rainfall averaging 20 in.

Immature leaves were scorched by foliar fertilizing, especially on sites under moisture stress. Since spraying usually occurred when leaves were fully grown, and fully grown leaves did not burn, this did not present a great problem.

In one of the experiments a similar grade fertilizer derived from ammonium polyphosphate (10-34-0), potassium sulfate, urea, and potassium chloride was compared to the urea-potassium polyphosphate material.

Foliar Fertilization Expensive

Foliar fertilization is an expensive undertaking, with total cost of three treatments coming to about $40 per acre at current prices, not including application. Even if the dramatic results of Iowa State's experiment had been duplicated, foliar fertilizing would barely pay for itself.

Allied Chemical Corp. is the only company that is commercially interested in foliar fertilization, having developed the compound Folian. It is not known whether Allied will introduce Folian on the market after the disappointing test results from across the country.

The difference between Iowa's indeterminate soybeans and Alabama's determinant types may be one reason for the disappointing results, but other experiments with indeterminant types also failed to produce the spectacular results of the 1975 Iowa State tests.

Further Research Needed

With further research and innovations, farmers may still be able to increase soybean production someday. The disappointing results of tests with foliar fertilization indicate that soil application is still the best method.

Effects of Animal Manure on Soybeans and Soil

F. LESLIE LONG, Coop. *USDA-Department of Agronomy and Soils*
E. M. EVANS, *Department of Agronomy and Soils*

THE PRACTICE OF USING MANURE at moderate rates to increase crop yields is many centuries old. However, little research has been done on how high disposal rates of manure affect a legume like soybeans. This question was addressed in a USDA-Auburn University Agricultural Experiment Station study that measured the effects of dairy cattle manure on soil properties and on soybean yield and composition.

Treatments were a high rate of manure (107 tons per acre), such as may be encountered in disposal, and a mineral fertilizer check. The manure was spread on the surface of a Dothan loamy sand and rototilled into the top 8 in. The check plots received 0-14-14 fertilizer at the rate of 1,000 lb. per acre.

Test plots were planted to Hutton soybeans about 4 weeks after the last manure application. Irrigation was used as needed. Each plot had four rows 40 in. apart. Seeding rate was 10 seed per ft., and germination was about 80%. The applied manure contained about 2% N, 0.7% P, and 1.6% K and Ca, which supplied about 4,000 lb. N, 1,500 lb. P, and 3,400 lb. each of K and Ca per acre. Most of the N was in organic form.

The manure addition caused considerable change in the soil properties, Table 1. Soil pH was increased about 2 units in the 0- to 12-in. depth, with some increase down to 24 in. The young soybean plants developed symptoms of iron deficiency, undoubtedly a result of the high soil pH. This iron deficiency was later confirmed by analysis. The deficiency decreased with age of the plants, and visual symptoms disappeared by the time the plants were 18 in. high. This coincided with a gradual lowering of soil pH. Apparently there was ammonia production soon after the manure was applied, which caused the soil pH to increase enough to reduce the solubility of iron below the critical level for soybeans. Later, perhaps as ammonia production decreased and its absorption increased, the resultant decrease in pH brought enough iron into solution to meet plant needs.

The amount of breakdown of the organic-N in the manure is indicated by the increase in nitrate-N in the manured plots, Table 1. Other salts were also increased by the manure, as indicated by the increase in electrical conductivity of the saturated soil solution. Although the salts decreased with depth, there were considerably more salts at the 24-in. depth in manured plots than in the checks. Carbon also increased to the 24-in. depth. Apparently some carbonaceous matter was moving down in solution form.

Analysis of stalks, seed, and nodules showed some differences among treatments, Table 2. Comparisons were made of plants from unfertilized areas outside plots, from fertilized checks, and from manured plots.

Organic nitrogen was highest in stalks, seed, and nodules when unfertilized, indicating high efficiency of N fixation and utilization without fertilization. In contrast, there were few nodules on plants where manured, and those present were small.

Manure caused a four-fold increase in nitrate-N in stalks, but had little effect on the nitrate-N content of seed. In contrast, manure increased the P, K, and particularly the boron content of the seed. Zinc content of stalks was greatly reduced by manure, but there was little effect on zinc content of the seed.

Soybean yield was significantly increased by the manure treatment: 49 bu. per acre as compared with 43 bu. on the fertilized checks. This increase resulted despite the iron deficiency that occurred in early growth stages on manured soybeans. Yields of manured plots likely would have been higher had lodging not occurred.

Reason for the yield increase from manure is not known. One possible explanation is the carbon dioxide enrichment of the air from decomposing manure. This was not confirmed, however, since measurements showed no differences in carbon dioxide evolved from the soil surface of check and manured plots. Wind turbulence probably wiped out any differences during early stages of growth. By the time the soybeans had sufficient growth to provide a canopy and reduce wind turbulence, probably most of the carbon dioxide had been evolved. Measurements showed less than 1 mg difference in carbon dioxide per day between manured and check plots.

Results of this study show that soybean yield can be increased by high rates of manure, but soil pH goes high enough to cause temporary iron deficiency. High salt concentrations occur down to at least 24 in. and little nodulation occurs.

TABLE 1. EFFECT OF DAIRY CATTLE MANURE ON SOIL PROPERTIES[1,2]

Soil sample depth	Soil pH		Nitrate-N		Electrical conductivity[3]		Carbon	
	Check	Manure	Check	Manure	Check	Manure	Check	Manure
In.			*p.p.m.*	*p.p.m.*			*Pct.*	*Pct.*
0-6	5.89	7.87	21	51	1.54	3.81	0.61	1.79
6-12	5.58	7.61	13	26	1.24	3.60	.42	.76
12-18	5.67	6.25	18	26	.78	3.52	.15	.36
18-24	5.35	5.71	14	25	.47	2.64	.09	.20
Mean	5.62	6.86	10	32	1.01	3.39	.32	.78

[1] Application rate was 107 tons per acre (dry weight).
[2] Soil sample was taken 2 months after manure application.
[3] Rating stated as mmhos per cm.

TABLE 2. EFFECT OF FERTILIZER AND DAIRY CATTLE MANURE ON COMPOSITION OF SOYBEANS

Plant part	Content							
	Org.-N	NO_3-N	P	K	Ca	Mg	B	Zn
	Pct.	*p.p.m.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*p.p.m.*	*p.p.m.*
Stalks								
Unfertilized	1.95	141	0.12	0.90	1.15	0.83	1	33
Fertilized	1.84	148	.12	1.10	1.52	.53	5	43
Manured	1.53	609	.65	2.75	1.03	.42	22	9
Seed								
Unfertilized	5.10	164	.60	2.04	.45	.61	8	46
Fertilized	4.93	171	.51	1.91	.43	.38	8	36
Manured	4.32	183	.86	2.78	.36	.47	43	45
Nodules								
Unfertilized	5.74	225	.37	1.39	.08	.25	5	36
Fertilized	5.18	172	.43	1.52	.23	.25	7	116
Manured	5.57	—insufficient sample for analysis—						

DICHLORVOS: Effective Against Ips Engraver Beetles

R. J. CIBULSKI and L. L. HYCHE, *Department of Zoology-Entomology*

BARK BEETLES (*Ips* and *Dendroctonus* species) are responsible for one of the most common and troublesome of problems encountered in growing and maintaining pine trees.

These beetles tunnel and develop silently in the inner bark (see figure) with their presence often remaining undetected until needles of dying infested trees begin to turn red or brown. Most species, particularly *Ips* engraver beetles and the southern pine beetle, prefer to attack damaged and unhealthy trees or, as with the *Ips* engravers, freshly cut pine. Populations tend to build up in such situations then spread to nearby trees. Efforts to control and prevent spread of these beetles often involve the use of toxic chemical insecticides for destruction of beetles and beetle brood in infested material. For many years benzene hexacloride (BHC) and lindane, the gamma isomer of BHC, have been used for this purpose. Although still effective, these materials are chlorinated hydrocarbon compounds and possess the undesirable characteristic of persisting in the environment – a characteristic which may severely restrict or even prohibit their use in the future. Consequently, researchers are looking at other less persistent insecticides as possible alternatives to chlorinated hydrocarbons for use in pine bark beetle control programs.

At the Auburn University Agricultural Experiment Station, dichlorvos (Vapona®), a relatively non-persistent organophosphorus insecticide, has been tested and compared with BHC for effectiveness against *Ips* engraver beetles, *I. grandicollis, I. calligraphus,* and *I. avulsus.* Dichlorvos concentrations tested were 1/16, 1/8, 1/4, 1/2, and 1%. The BHC concentration used was 1/4%, the standard rate usually recommended for *Ips* beetle control. The carrier for each material was No. 2 diesel fuel oil. A treatment consisting of fuel oil alone was also included. Materials were applied as coarse sprays, to point of runoff, to the bark of *Ips*-infested loblolly pine bolts. Seventy-two hours after treatment all bolts were peeled and the mortality of *Ips* determined.

Test results are summarized in the table. Significant *Ips* mortality occurred in each chemical treatment. In infested material sprayed with fuel oil alone mortality ranged from 20 to 54% among species, indicating the value of oil as the carrier in insecticidal sprays for bark beetle control. Beetle mortality in bolts sprayed with BHC, the standard recommended insecticide, ranged from 80% for *I calligraphus* to 100% for *I. avulsus* with an average of 92% for all species. In the dichlorvos treatments significant *Ips* mortality was obtained with each concentration tested. At the higher concentrations, 1, 1/2, and 1/4%, mortality approached 100% for all *Ips* species. Beetle kills in all dichlorvos treatments were statistically equal to that in the BHC treatment.

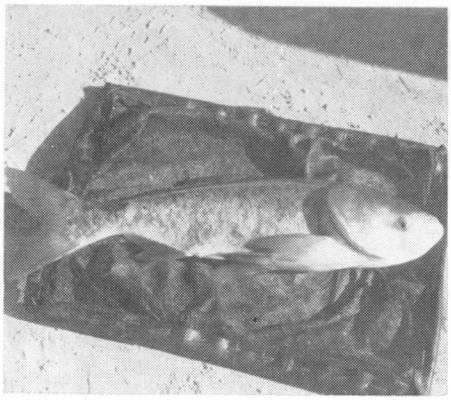
From these results, it appears that dichlorvos may be highly effective in the destruction of *Ips* beetles developing in the inner bark of pine, and may have promise as an alternative to chlorinated hydrocarbon insecticides for pine bark beetle control. However, use of dichlorvos against bark beetles is still experimental; consequently, report of these results does not constitute a recommendation.

MORTALITY OF *Ips* ENGRAVER BEETLES (ALL DEVELOPMENTAL STAGES COMBINED) FOLLOWING TREATMENT OF INFESTED PINE BOLTS WITH DICHLORVOS AND BHC SPRAYS[1]

Treatment	Mean percent mortality by species[2]			
	I. grandicollis	*I. calligraphus*	*I. avulsus*	Mean all *Ips* species
Check-untreated	0.5 a	2 a	0 a	0.83 a
Fuel oil only	54.0 b	27 b	20 b	33.7 b
BHC, 1/4%	96.0 c	80 c	100 c	92.0 c
Dichlorvos, 1/16%	90.5 c	84 c	100 c	91.3 c
Dichlorvos, 1/8%	90.5 c	90 c	100 c	93.5 c
Dichlorvos, 1/4%	99.5 c	100 c	100 c	99.8 c
Dichlorvos, 1/2%	99.5 c	97 c	100 c	98.8 c
Dichlorvos, 1%	98.5 c	100 c	100 c	99.5 c

[1] BHC and dichlorvos applied in No. 2 diesel fuel oil.
[2] Means followed by the same letter are not significantly different at the 0.05 level.

Pine bark beetle tunnels in inner bark; Ips engraver beetle (left) and southern pine beetle (right).



This marketing project was concerned with an exotic species of fish native to the Amur River in China.

ESTABLISHING a MARKET for an EXOTIC FISH SPECIES

E. W. McCOY and M. L. HOPKINS
Department of Agricultural Economics and Rural Sociology

CATFISH MONOCULTURE has become relatively well established in the Mississippi Delta and west central Alabama.

Increased construction and fuel costs have caused farmers and researchers to seek additional means of increasing production from existing ponds. Higher stocking rates lead to increased feed requirements and often result in oxygen problems during the latter stages of the production cycle. Excess feed and other waste materials enrich the pond, causing an excessive buildup of aquatic plants. Under adverse conditions the plants compete with fish for the available oxygen in the water.

A chemical weed killer, cleared for use in fish ponds, can be applied to thin the plankton population. Great care must be taken in application to avoid killing all the plankton or adversely affecting fish growth. A mechanical aeration device can be used in the pond when oxygen levels drop below a safe level. Both techniques are relatively costly and neither utilizes the rich nutrients available in the pond.

Auburn researchers have been investigating a third alternative: An aquatic organism to use excess nutrients created in catfish ponds. The aquatic organism should either allow more catfish to be produced at the same cost or the same amount to be produced at a lower cost. The organism should not represent a potential pest if it escapes from the pond.

Auburn research has included aquatic plants and animals. Included among these was *Aristichthys nobilis,* a filter feeding fish, native to the Amur River in China, that utilizes plankton.

In November 1976 a polyculture pond including catfish and the filter feeder were harvested. Data on harvest weights and other physical characteristics were recorded and the catfish were sold. Durthe 2 years the fish were in the pond, the filter feeders grew from fingerlings to average weight of 8 lb. Approximately 2 tons of fish were available for the marketing test.

A marketing study was initiated to test consumer acceptability of the filter feeder. Because the product supply was limited, the study was postulated on local sales by an individual farmer. As an adjunct to the study a limited supply of dressed product was sold through local grocery stores.

Marketing began the first week in December with direct sales in the supermarkets plus promotional distribution of eight fish to prospective buyers. Only word-of-mouth advertising was conducted during the market period. After the initial contacts only one additional buyer was solicited. The sales data by weeks are shown in the table.

Sales steadily increased for 3 weeks, then declined essentially to zero during Christmas and New Years. Grocery store sales were not resumed following the holiday period to ensure a large supply of product for market testing of live sales. Following New Years, direct sales of live fish increased steadily until the end of January, when the study was terminated since the available supply was reduced to a reserve for broodstock.

After the initial contact with potential buyers all sales were made on a delivered basis. Essentially all sales were made to two fish markets and four individuals. The individuals ultimately purchased more fish than the fish markets.

The major adverse factor in the study was the size of the fish. An 8-lb. fish at $0.50 per lb. represents a major meat purchase. When ordering fish the buyers specified a preference for 3, 4, or 5-lb. fish. Limited data indicate a smaller fish could sell for a higher price per pound. One buyer marketed the product per fish rather than on a pound basis. The 6-lb. fish at $3.50 sold more readily than 8-lb. fish at $4.00.

January 1977 was one of the coldest months Auburn has experienced in many years. No attempts to establish new markets were made during early January because the ponds were frozen and the product could not be harvested. Market saturation was not reached during the test period. During the final week requests that could not be filled approximated the quantity sold.

Few adverse comments regarding the product were noted. The fish was relatively difficult to scale and most buyers skinned the product. Flavor, texture, aroma, appearance, and other factors were highly acceptable. The meat is white and has a pleasing taste. When taste tested with catfish the product was preferred, while the catfish flavor was adjudged bland.

With market evidence that the product is acceptable at a farm price equaling catfish, additional production research is necessary to determine the efficiency of the fish in conjunction with catfish or as the primary species in a culture system. Economic analysis to determine the production costs of the fish in polyculture is also necessary. Fish processors also need to study the feasibility of incorporating the fish in their product line.

WEEKLY SALES OF EXOTIC FISH SPECIES

Date	Sales, by market type			
	Individual	Fish market	Super Market	Total sold
	Lb.	*Lb.*	*Lb.*	*Lb.*
December 2-4	---	100	154	254
December 9-11	---	100	242	342
December 16-18	172	200	118	490
December 21-22	122	---	---	122
January 6-8	200	107	---	307
January 10-15	186	296	---	482
January 17-21	571	107	---	678
January 27-29	648	208	---	856
TOTAL	1,899	1,118	514	3,531

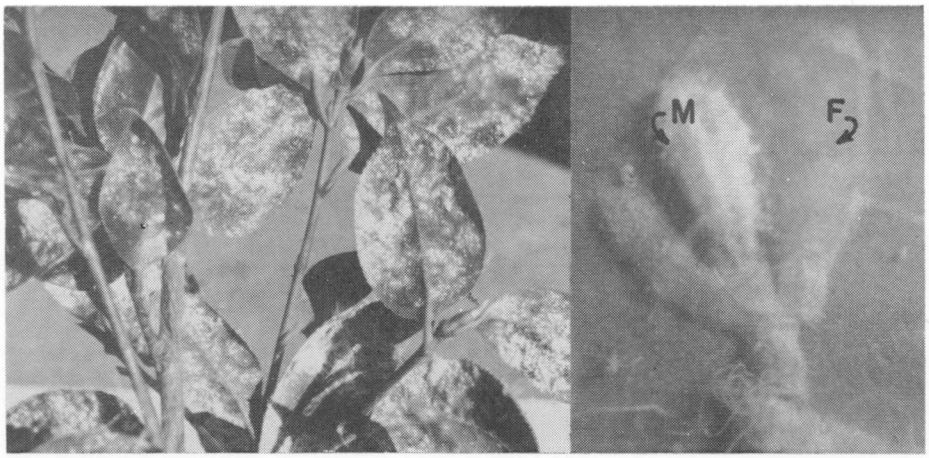


FIG. 2. Heavy infestation of tea scale on underside of leaves (left) and tea scales developing on butternut squash in the laboratory; M represents the male and F the female (right).

CONTROL OF TEA SCALE ON CAMELLIAS

C. A. KOUSKOLEKAS and M. L. WILLIAMS, *Dept. of Zoology-Entomology*
R. L. SELF, *Ornamental Horticulture Field Station*

Tea scale, *Fiorinia theae* Green, has long been an important pest in the Southeast. It is widely distributed in Alabama (reported from 39 counties) and is considered the most destructive insect pest of camellias. It also infests a few other species of ornamental plants, primarily burford and rotunda hollies.

Tea scale ruins the appearance of camellia plants by yellowing the leaves, Figure 1. It also reduces plant vitality which is reflected in impaired flower production, premature defoliation, and stunting. Infested cuttings often die before rooting, and weakened plants are more susceptible to attack by other pests.

Tea scales form colonies which are confined to the underside of the leaves, Figure 2. Colonies include both immature and adult stages of this insect. Viewed from a distance, these colonies have a whitish appearance caused by the profuse threads of white wax produced by the males. When infestations are heavy, cottony masses of wax filaments can be seen hanging from the leaves. Under close observation, individual insects can be detected. Each individual is hidden by a cover made of wax secreted by the growing insect. The cover of the male is white and fragile whereas that of the female is brown and hard, Figure 2 (right). The body of the insect lies under this cover.

Active infestations can be found almost year-round, although activity slows down during winter. There are several overlapping generations per year, because each female lays eggs for several weeks and eggs hatch almost continuously.

Control of tea scale has been investigated at the Auburn University Agricultural Experiment Station. Tests, involving recommended and experimental insecticides as well as methods and timing of applications, were conducted under natural conditions in camellia gardens. Scale infestations in these gardens varied from moderate to heavy. One spray with summer oil (such as Florida Volck or Oilicide) in April was found to kill 60% of the insects, while one spray with the systemic insecticide dimethoate (Cygon) gave 75% control. Cygon also controlled spider mites and bud mites (which cause bull heading and flower bud drop). On the other hand, Cygon is toxic to several ornamental plants (particularly hollies, which may be severely defoliated) and should be used only according to label directions. Malathion was largely ineffective, because it kills only very young insects (crawlers).

FIG. 1. Camellia leaf showing typical discoloration caused by feeding tea scale.

Soil applications of disulfoton (Di-Syston) granules gave unsatisfactory results; this insecticide, however, protected uninfested plants from infestation. Excellent results were obtained with soil applications of aldicarb (Temik) granules. However, this compound is highly toxic, should be applied only by certified personnel, and is not registered for use around the home.

In general, two applications of an insecticide spaced 1 month apart were most effective. For example, one application of Cygon in April followed by a spray in May provided 95% control.

When applying sprays, thorough coverage of leaf undersurfaces is essential for effective control, because tea scale is confined to the underside of the leaves and is also protected by wax secretions. The presence of tea scale colonies following treatment does not necessarily mean that control was not obtained. Tea scales are attached to the leaves with wax secretions and few of them drop off immediately even when they are dead. Colonies of dead scale insects may remain on the plant several months.

An important factor leading to tea scale problems is the failure to locate infestations before they spread. Initial infestations can be detected by thorough and frequent examination of the plants. Simple control measures at this stage will prevent spread. When camellias are neglected for 3-4 years, heavy infestations develop and patience is necessary. In this case, a 2-year program of intensive care (such as three treatments per year, applied in April, May, and September), may be needed before the appearance of the plants improves appreciably.

Research has also been conducted on tea scale biology at Auburn University. A method has been developed for maintaining active colonies of tea scale on butternut squash under laboratory conditions, Figure 2. This technique has allowed researchers to study tea scale life history and growth in more detail. Such studies should provide the basis for the development of better methods for coping with this important pest problem.

PARTICLEBOARD From Loblolly Pine Logging Residue

E. J. BIBLIS and GEORGE COLEMAN
Department of Forestry

We assume that removal of logging residues, without needles, from Southern forest would not deplete the forest land of nutrients. Utilization of these residues then will contribute to conservation of our natural resources. The importance of this residue as a potential source of wood fiber has been reported in several studies particularly for the west coast and southern regions. Logging residue after clear-cutting in southern forests represents more than 25% of standing tree volume; even larger proportions of residue remain after partial cutting. This study concerned the suitability of loblolly pine tree tops and branches of various diameter classes as material for industrial grade particleboard that meet commercial standards.

Logging residue of three diameter class loblolly pine tree tops and branches was collected from two logging sites in Lee County, Alabama. The three classes were designated A, B, and C with 4 in., 3 in., and 2 in. base diameter, respectively. In addition a control class D was included that consisted of the upper 4 ft. log with 4 in. small end diameter (last portion of merchantable stem). Each group was separately chipped, flaked, and dried to about 7% moisture content. Three boards 24 in. square, 5/8 in. thick with an average density of 48 p.c.f. were made from furnish of each class. Furnish was sprayed with urea-formaldehyde resin at a rate of 7% resin solids and wax emulsion at 1%. Hand formed mats were pre-pressed for 10 seconds with 170 p.s.i. between steel cauls and hot-pressed at 340° F. for 5.3 minutes to the desired thickness. After fabricating, each board was conditioned at 72° F. and 65% R H and then cut into six flexural strips (3 in. x 20 in.), which were tested destructively according to ASTM D 1037-72 to determine modulus of elasticity (MOE) and modulus of rupture (MOR). From the undamaged portion of each tested static bending strip, the following specimens were cut and tested: (a) one internal bond (1B) block (2 in. x 2 in.); (b) one fastening test specimen (2 in. x 6 in.) to determine nail and screw holding; and (c) one dimensional stability specimen (3 in. x 9.5 in.) to determine linear expansion (LE), water absorbing (WA), and thickness swelling (TS) from 50 to 90% RH.

Results of all tests for strength, stiffness, internal bond, and fastening properties are shown in the table. From the analysis of the results the following can be concluded:

Tops and branches, 2 in. to 4 in. base diameter, of loblolly pine trees can be used to make commercially acceptable particleboard when half of total needles are removed. Inclusion of all attached needles in boards significantly reduces all strength and stiffness properties, particularly internal bond strength.

Exclusion of twigs has no significant effect on strength properties of boards made from tops and branches with a 4-in. base diameter.

Properties of boards are not significantly affected by different base diameters of tops and branches between 2 and 4 in.

Dimensional stability of boards made from tops and branches is equivalent to that of commercial boards of similar density and species. Dimensional changes are not significantly affected by different base diameters or by needles and twigs.

Selected Properties of Particleboards from Loblolly Pine Logging Residue[1]

Residue group	Description (base diameter)		Density	MOE	MOR	Internal strength bond	Nail holding (face)	Screw holding (face)
			Pcf	*10^3 P.S.I.*	*P.S.I.*	*P.S.I.*	*Lb.*	*Lb.*
A-1	4″ with all needles	Av.	49.1	346	2145	41	75	261
		($s_{\bar{x}}$)	(.2)	(8)	(69)	(5)	(4)	(9)
A-2	4″ with 2/3 needles		48.6	396	2423	58	82	248
		($s_{\bar{x}}$)	(.2)	(5)	(47)	(6)	(4)	(7)
A-3	4″ without needles		48.1	401	2884	99	96	347
		($s_{\bar{x}}$)	(.2)	(7)	(51)	(5)	(5)	(7)
B-1	3″ with all needles		48.6	356	2056	50	71	235
		($s_{\bar{x}}$)	(.1)	(6)	(53)	(6)	(3)	(7)
B-2	3″ with 2/3 needles		49.3	391	2205	62	85	269
		($s_{\bar{x}}$)	(.2)	(8)	(47)	(4)	(2)	(8)
B-3	3″ without needles		48.1	403	2608	107	85	317
		($s_{\bar{x}}$)	(.3)	(7)	(46)	(8)	(4)	(7)
C-1	2″ with all needles		47.6	349	2099	26	74	216
		($s_{\bar{x}}$)	(.2)	(6)	(38)	(3)	(5)	(6)
C-2	2″ with 2/3 needles		48.2	404	2307	53	88	251
		($s_{\bar{x}}$)	(.2)	(6)	(46)	(4)	(3)	(7)
C-3	2″ without needles		47.4	413	2799	90	99	333
		($s_{\bar{x}}$)	(.1)	(6)	(48)	(6)	(4)	(6)
D-1	Control with bark[2]		49.2	516	3072	112	110	338
		($s_{\bar{x}}$)	(.3)	(8)	(73)	(3)	(6)	(7)
	Required by CS 236-66			400	2400	60	----	225

[1] Each value is the average of 18 specimens, except density which is the average of 3 specimens.
[2] Last portion of merchantable stem.

AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY
AUBURN, ALABAMA 36830
R. Dennis Rouse, Director
PUBLICATION—Highlights of Agricultural Research 3/77 10M
Penalty for Private Use, $300
POSTAGE PAID
U.S. DEPARTMENT OF AGRICULTURE
AGR 101
BULK RATE
U.S.MAIL