Proceedings

FOURTH NATIONAL PEANUT RESEARCH CONFERENCE

Held at

UNIVERSITY OF GEORGIA COLLEGE OF AGRICULTURE
COASTAL PLAIN EXPERIMENT STATION
and
ABRAHAM BALDWIN AGRICULTURAL COLLEGE
TIFTON, GEORGIA

JULY 14-15, 1966

Proceedings

Papers and Addresses

FOURTH NATIONAL PEANUT RESEARCH CONFERENCE

Tifton, Georgia

July 14-15, 1966

Sponsored by

PEANUT IMPROVEMENT WORKING GROUP

in cooperation with the

UNIVERSITY OF GEORGIA COLLEGE OF AGRICULTURE
COASTAL PLAIN EXPERIMENT STATION

Proceedings Edited by

Curtis R. Jackson, *Plant Pathologist*
Coastal Plain Experiment Station, Tifton, Georgia

and

Sam Burgess, *Editor*
Agricultural Experiment Stations
University of Georgia
Athens, Georgia

Program Committee

Wallace K. Bailey
Don A. Emery
Curtis R. Jackson
J. Frank McGill

Contents

Papers and Addresses

Abstracts of Talks Presented

Papers and Addresses

Welcoming Remarks to the Fourth National Peanut Research Conference

John H. Owen, *Director, Agricultural Experiment Stations, University of Georgia*

I consider it a pleasure to welcome you to the Fourth National Peanut Conference. We in Georgia are proud of the record that you research scientists have contributed to the development and progress of the peanut industry in the South. I do not know of any crop that has moved forward as rapidly as that of the peanut, and this has largely been accomplished through research over the past twenty years. I am particularly impressed with these meetings since the majority of the scientists who are responsible for the progress made in the peanut production are present among you today.

In 1943, the peanut yield was 600 to 700 pounds per acre. At that time, we thought this was good, and that little could be done to improve yields. Twenty years of research doubled the yield 1200 to 1300 pounds per acre. The increased support of peanut research in Georgia through the Georgia Agricultural Experiment Stations, the Georgia Commodity Commission for Peanuts, and USDA contracts coupled with research findings from other states during the past three years have resulted in an increase of 600 pounds per acre in this state alone.

Through research, you have provided new methods of cultivation, improved fertilizer practices, found controls for insects, fungi, and nematodes, developed new varieties and improved methods of harvesting and curing. You have encountered new problems such as aflatoxins, seed treatments, storage and food processing. Research is already underway to provide answers to these problems, and if your record in the past is any indication, I have the greatest confidence that you will provide the solutions in the near future.

I encourage meetings of this type and definitely feel that it is through the coordinated and cooperative efforts of this group that has made your program so successful.

Dr. Jackson has done an excellent job of arranging your program. It is a pleasure to have you here, and I hope you will enjoy your stay.

Report from the National Peanut Council Research Committee

George F. Hartnett, *Chairman*

It is a pleasure to be here today and I appreciate the invitation from your program committee to report to you on behalf of the research committee of the national peanut council. As you all know, the national peanut council membership includes all growers, shellers and brokers of raw peanuts, plus many manufacturers of peanut foods and many suppliers of equipment and services to the peanut industry. Thus our research committee enjoys representation from all segments of the peanut industry.

This is the third P.I.W.G. research conference in which I have been invited to participate, and at first I hesitated to appear because I knew I could neither present any advanced knowledge of the aflatoxin problem, nor deliver a learned discourse on it. Yonr papers at these meetings have always been very impressive and of real value to the industry, and I did not wish to usurp another speaker's time. But it was soon apparent that I could deliver one message that, in the opinion of our committee, would be of value.

The core of these remarks is stated most simply: the aflatoxin problem has not been licked, gentlemen, and there is no evidence that it will be licked in the 1966 crop.

A great deal of research has been devoted to mycotoxins and peanuts during the past three years, and it has been effective, snbstantial and of real value. Words of praise can be directed toward all parts of the industry and to the U. S. Department of Agriculture for the admirable way in which everyone involved has joined forces to build up a quality control system in this industry that guarantees that the peanut products now sold to the public are totally wholesome, and that the quality of peanut products has actually been improved substantially. Our current consumption of 1965 crop peanuts is more than 7 percent above last year's consumption, and this surely indicates the quick acceptance in the market place of high quality peanuts.

Our actions have been defensive, however, and have really boiled down to all of us trying onr hardest to prevent the growth of bad quality peanuts, or to remove the defective peanuts from the peanut stream as it moves from grower to housewife. What we have accomplished so far is to fight for time and to improve our appearance and to avoid a disaster. But the real struggle, the one that will dictate eventnal success or failure, is being waged by you people. We look to you for the all important answers that you must gain from effective, relentless, expensive, and patient research. You must tell us how to prevent aflatoxin growth

or how to destroy it without harming the peanut, or how to effectively detect it and accurately measure it.

This is an impressive industry in which we have all involved ourselves. It is composed of intelligent, realistic and hard working people and companies that will not rest until the aflatoxin threat has been eliminated. If research provides the answers and the knowledge we will make them work, one way or the other. The peannt has never been appreciated more than it is right now in this country. The national peanut council export committee is enthusiastic about the unlimited future for peanuts in Europe and all over the world. We cannot allow aflatoxin to slow us down or discourage us. But I reiterate, the problem has not been licked, and you must redouble your efforts to provide the industry with eventual solutions.

The 1964 and 1965 crops have produced high quality peanuts. The good Lord and our growers have combined to deliver to the shellers some of the finest peanuts we have ever grown in this conntry. Thus we have had a breather, and time to decide how to handle poor crops. But how *do* we handle a poor crop? What if next month's harvest delivers a 1954 or 1957 crop? Do we know how to eliminate aflaxtoxin from it? Can we prevent aflatoxin from affecting a good crop? The answer is no. We must turn up an affirmative answer to these questions before we have that bad crop that the law of averages makes us worry about. Most of the literature indicates that much of the aflatoxin developes before the peanuts are shelled. After they are shelled we feel that a common sense quality assurance program will not allow aflatoxin to develop. Therefore much of the research must be devoted to the peanut from the moment it is planted until it reaches the shelling machine. From that point on it is the responsibility of the sheller and manufacturer to pick-out the unwholesome peanuts, but our most effective work can and should be done at the grower level. This is not only good sense, it is also good economics! Damaged and immature peanuts lose money for everyone, but especially for the grower. The better the quality that we produce, the more peanut products will sell, and the more prosperous all will become.

During the past year our committee mailed several questionnaires to shellers and manufacturers throughout the country in order to determine their activities concerning the aflatoxin problem. The sheller questionnaire was returned by nearly all of the active shellers and indicated that during the 1963 and 1964 crop years the shellers had spent seven million dollars on inspection devices, sampling equipment, drying and storage facilities and other improvements. We will send out another questionnaire to cover the 1965 and 1966 crops and I suspect we will discover that an additional $7,000,000 and maybe much more has been spent by the shellers to improve peanut quality.

We sent a questionnaire to the 407 American food processors who

use peanuts and our reply was 35 percent. We are now trying to obtain a greater return from tbe manufacturers. Preliminary returns show the responding mannfactnrers were aware of the quality control program and were cooperating with it. Many are inspecting raw peanuts and finished products for aflatoxin, and nearly $2½ million has been spent over the past two years by these processors on improved storage, inspection devices, and other equipment. We suspect tbe completed survey will reveal much larger sums of money spent on quality improvement at the manufacturer level.

Another snrvey was made by our committee and the results are most revealing. A number of the large food mauufacturing corporations that use peanuts in some of tbeir products keep accurate records of all raw peanuts received by the company. These companies have extremely tight quality specifications for their raw peanut purchases, and so the peanuts they receive can fairly be said to be of the highest quality. This survey revealed that nearly 10 percent of the peanuts that they received at their plants or designated cold storage warebouses contained measured amounts of aflatoxin in excess of 30 parts per billion. These findings lead to two immediate conclusions:

1 - The first is that the manufacturers are doing a satisfactory job of repicking and cleaning the raw peanuts prior to their use in food products. Assays of the finished products that contained these peanuts showed that the products were wholesome. It is not an easy task, by tbe way, to persuade many of our manufacturers that they must further clean the raw peanuts. They feel the delivery of a clean aud wholesome peanut is the responsibility of the grower *and* the sheller and they cite other commodities that they purcbase where their suppliers are not allowed to "pass the buck". Our committee bas given a great deal of energy to enlightening the manufacturer about the peculiar nature of the aflatoxin problem, however, and once the manufacturer understands it he gives us his full support. We encourage further examination of raw peanuts before the roast and even after the roast whenever possible.

2 - The second conclusion is that raw peanuts showing contamination are being delivered from the 1965 crop, a crop that produced high quality peanuts. These peannts were handled by responsible shellers and met all the requirements of the industry quality control program. Once again, then, we realize that more research and effort must be directed toward preventing and removing aflatoxin, particularly at the farm level. If broad research can institute new practices and improve existing practices that are more effective at the grower level, then the aflatoxin problem and its enormous cost to the industry will be substantially reduced.

Several suggestions have been endorsed by our committee and I offer them now for yonr consideration. The first is that while the 1966 crop is being harvested and the farmers stock is being graded at the various

points in the three principle growing areas, a specific program be instituted to examine farmers stock peanuts for aflatoxin. This could be accomplished by establishing inspection points tbroughout each area so as to cover the entire crop. The purpose of this system would be twofold. It would help to compile a record as to what points in each area might be aflatoxin prone, or might bave dangerous soil conditions, or might have experienced a bad weather pattern. If the complete history of each sample was recorded tbe total data might also suggest where our harvesting practices could be improved. It is hoped tbis data could be compared with any similar records from the '64 and '65 crops.

Such a program wonld also serve to establish an "early warning" system by which we would be immediately alerted to areas of trouble and might quickly work to diminish or erase the problem at that particular point. If our objective is to learn more about aflatoxin infection at harvest, as well as remove contaminated farmers stock peanuts, then this suggestion must have merit.

Another suggestion is to employ computerized weather records in the producing areas. The cotton industry has made good use of such records and the cotton research advisory commuttee has suggested using them to aid in planting and harvesting decisions so as to help in reduciug production costs as well as in avoiding unfavorable weather conditions.

More research might be devoted to improving farm machinery. The objective would be to reduce peanut hull breakage and thus reduce mold infection of the peannt kernel. The USDA has a project for 1965 and 1966 in the broad area of agricultural engineering, but farm machinery improvement would be a specific project that does go to the core of preventing mold infection.

Our committee meets regularly with the Food & Drug Administration. They constantly ask for dose-response data and this data is not very complete. The western regional lab has recent data on swine that was negative up to 200 or so P.P.B. in the total ration. This data is most helpful and more is needed. Here in Georgia, for instance, there could be dose-response work on chickens and other animals. It should be reiterated here that there is still no evidence of human toxicology, but while this is encouraging it mnst also be realized that F.D.A. is continuing to work to improve its methodology, and written and oral statements continue to eminate froin that agency concerning the possible lowering of the levels which they feel can be accurately established and defended.

Our quality control program reqnires more research on the relationship between contamination and peannt kernel size and maturity. The same is true of the relationship with minor defects in peanuts. Much of the existing data is contradictory, unclear and indecisive.

These are just a few of the areas where additional research might be initiated and expanded. The main point is to stimulate your interest and

rekindle your enthusiasm. If the research committee can be of assistance to you, please contact us. Whatever you do, please remember that the aflatoxin problem has not been solved and the peanut industry will remain extremely vulnerable until it has been solved.

Again, my thanks for your kind invitation and your polite attention.

Report on the Peanut Marketing Agreement

Roy E. Parrish, *Manager,*
Peanut Administrative Committee, Atlanta, Georgia

I am supposed to talk abont the Marketing Agreement. Yon are all familiar with the fact that the Marketing Agreement is a voluntary set-up created by the Peanut Industry to provide quality control with indemnification coupled with it. We have 99 signers to this Marketing Agreement, operating a total of 122 plants in all three areas. In fact, we have practically a 100 per cent signup to this Agreement.

This Agreement is administered by a Committee, consisting of 18 members, elected from the peanut shellers and growers within the industry. Nine of these members are shellers and nine are peanut growers. There are 3 peanut shellers and 3 peanut growers on the Committee from each producing area. These gentlemen have all done fine work and are due our thanks for the time and effort they have devoted to the interests of operating the Marketing Agreement.

We have had a full year's experience in operating this Agreement and I mnst say that, in my opinion, it has operated fairly smoothly and successfully. We have had a total of 85 claims, and have spent, in indemnification, including our estimated liability on the few claims now pending, a total of around $225,000.00. Of course, our indemnification on the 1965 crop extends to December 1, 1966, and there will probably be more claims.

I would like to say that in my opinion, compliance with this Marketing Agreement has been very good. We have had very few flagrant violations, and I wish to thank each of those who have signed the Marketing Agreement for the cooperation they bave extended to the Atlanta office. The reporting has heen very good, on the whole.

Let me stop here and pay tribute to Mr. Joe C. Genske, Chief of the Specialty Crops Branch, C&MS, Washington, under whose leadership we handle the Marketing Agreement program. He and his staff have been very considerate and helpful to us in operating the office. I wonld also like to pay tribute to Mr. J. E. Thigpen of the ASCS, whose CCC Purchase Program is vital to the success and operation of the Marketing Agreement. Without the purchase program, this Marketing Agreement would not work. Mr. Thigpen has been kind and considerate and most helpful at all times, and we owe him a debt of gratitude.

Our procedure for indemnification is not complicated. When a shipment is rejected by a buyer because he feels that the aflatoxin content is too high, we get in touch with the nearest Inspection office to the location and we have a big sample drawn and forwarded to the C&MS Laboratory, Washington. When we receive the findings of this laboratory, we immediately get in touch with the buyer, and in many cases, it is found that the shipment is really not bad enough to be rejected. As a matter of fact, we have secured acceptance on nearly half of the rejections which we have received.

I would like to emphasize that the reports and the information the handlers provide to us is held strictly confidential. On matters of a competitive nature, we are not allowed to reveal information to anyone except the Secretary of Agriculture. Our money is deposited in banks approved by the U. S. Treasury Department for the safekeeping of Government funds, and is all secured according to the regulations of the Treasury Department. Of course, we try to earn as much interest as possible, and have been fairly successful in that regard.

The Marketing Agreement is a continuous thing, and it runs until it is voted out or terminated by the Secretary of Agriculture, but the Regulations issued thereunder must be re-enacted and re-published from year to year. The full Peanut Administrative Committee met in Atlanta, Georgia, on June 1, 1966, and made a few changes for the 1966 crop, which I feel that I should bring to your attention.

In taking up the matter of assessments, the Committee voted to reduce the assessment for indemnification on the 1966 crop from $2.00 per ton as we had on the 1965 crop, to $1.00 per net weight ton on the 1966 crop. This was possible hecause of the accumnlation of an idemnification reserve and a lower rate on insurance for the 1966 crop.

A sub-committee of the full committee has arranged for insurance coverage on the 1966 crop in the amount of 4½ million dollars, to take effect after the Committee bas exhausted an indemnification reserve of 1½ million dollars, which it expects to have available for the 1966 crop. The rate on this insurance policy will be 40¢ per ton on all farmers' stock peanuts acquired by handlers, as compared to a rate last year of 56¼¢. Quite a savings.

The Administrative assessment of 20¢ per net weight farmers' stock ton, as was in effect on the 1965 crop, was continued to cover the coming crop.

Another change which was approved by the Committee deserves your full attention. The following clause was added to the Indemnification Regulation and has to do with your sales contracting:

> Should any handler enter into any sales contract which fixes the level of aflatoxin at which rejection may be made, and hence conflicts with these terms and condition, the handler doing so will be ineligible for indemnification payments except upon the Committee's findings that acceptance of such contract was inadvertant with respect to any claim filed with the Committee on or after the date of such contract and for the purposes of this provision the claim shall be deemed to be filed when notice of possible rejection is first given to the Committee.

The Committee had previously voted to change the idemnification price on all peanuts idemnified from 107 percent of the CCC Purchase price to the full contract sales price, meaning that the handler will be indemnified for the sales price at which the peanuts were originally sold.

In the last Committee meeting, the Committee also voted that, beginning with the crop of 1967, Runners with splits over a 15/64 slotted screen shall not be eligible for indemnification. Runner peanuts over a 16/64 slotted screen will continue to be indemnified. This was controversial, of course, but was finally approved.

You can see that there are not too many radical changes in the regulations proposed for the 1966 crop. If I have any recommendations to make to handlers under the Marketing Agreement, I would say that we ueed to bend every effort to improve our plants so that we can produce a better quality sbelled peanut and to prepare them in the best possible manner.

This aflatoxin is something we know very little about. As a matter of fact, I cannot truthfully say that I have learued too much about it in my work with the 1965 crop. It is a very difficult thing to pinpoint any causes iu specific cases, and it crops out in the place you sometimes least expect it. Therefore, it behooves all of us to do everything we can to avoid some of the things that we know can be conducive to aflatoxin. I recommend to each sheller that you do not acquire any peanuts which you feel have been mishandled and look well into storage condition on your farmers' stock peanuts.

If the aflatoxin is not too high in the shelled peanuts, it can be removed by the mauufacturer in roasting, blanching and picking the peanuts before processing into peanut products. We are urging all manufacturers to look well into their preparation process and make every contribution they can to a successful handling of this problem.

We appreciate greatly the work your Peanut Improvement Working Group is doiug, both collectively, and as individuals, and we feel sure that the contributious you are making and will make will result in moviug this industry forward in great strides in its effort to control and bring relief from this great problem of aflatoxiu as it effects the peanut industry. It seems that this problem confrouts everyone in the industry from the grower and the sheller to the manufacturer, and all along the line, improvements must be made. We welcome all of the help we can get

and I am sure you gentlemen of the Peanut Improvement Working Group are deeply concerned with ns.

In closing, let me say that there is much research going on, and one of these days, we are going to find some way to handle aflatoxin. Until that time, industry must bend its back to make every effort to control it to the highest possible degree.

The Influence of Time of Harvesting Spanish Peanuts on Plant, Fruit and Kernel Characteristics

J. Jerry Collins and Ralph S. Matlock
Agronomy Department, Oklahoma State University

Introduction

More precise information is needed to determine the best time to harvest maximum yields of high quality peannts.

There are several reasons for concern in determining the maturity of peanuts. The indeterminate growth habit of peanuts make it difficult to predict the best time to harvest. Off-flavor has been associated with both immature and overmature peanuts particularly with improper curing. The wide range of moisture in peanuts with large quantities of immature nuts causes complications in curing. Hardness in peanuts has also been associated with the stage of maturity. There is no practical method of separating the mature from immature nuts. These stndies were conducted to measure some plant, fruit and kernel characteristics to determine their relation to maturity.

Review of Literature

Higgins (4) reported that peanut varieties with sequential branching such as Valencia and Spanish are likely to be more uniform in maturity than varieties of the alternate branching gronp snch as Virginia and Runner.

According to Teter (7), Dickens defined maturity in terms of the interior color of the hull and found the immatnres to have more "off-flavor" than matures.

Toole, Bailey and Toole (8) described bunch and runner peanut seed in eight grades according to the degree of maturity based largely on texture and color of seed. Mature seed were full-sized, brown to deep pink in seed-coat color and the outer seed-coat layer was papery thin to thin. Immature seed were one-half the size of mature peanuts, with light pink to faint pink seed-coats.

Watson (9) emphasized the importance of keeping the amount of immature peanuts low for best quality of peanut hutter. Garren (3) reported that one of the ways which disease adversely affects quality is

increasing the proportion of immature kernels. Disease impairs vigor by arresting development of some seeds and damaging otherwise sound mature seed. Many imperfectly formed and immature seed are blown out in the picking operation. Plots of Adkins Runner where leafspot was controlled had larger pod size, 3 percent more extra large kernels and 5.5 percent more SMK than the check plots.

Teter (7) stated that the peanut reaches maturity when, although vitally attached to a living plant, it reaches an approximate maximum size and ceases to increase in dry matter content. Even though a peanut is mature it is not necessarily ripe. Ripening is a physiological change of non-growing peanuts and requires the presence of water. The peanut is considered ripe when it exhibits sound physical structures and acceptable flavor even though it may still contain too much water for safe storage.

Mature peanuts should require a shorter time for ripening than immature peanuts. Freshly dug peanuts dried before ripening exhibited poor physical structure and flavor according to Teter (7).

Holley (5) stated many immature peanuts may be eliminated by careful grading, but a few peanuts are in the borderline area between mature and immature and cannot be eliminated. The water content, carbohydrates, protein and oil do not change abruptly in the course of maturation. In fact, maturity was marked more by a slowing down of the growth process. When the moisture of the skin reached 50 percent the peanut kernel was considered mature (5).

Mills (6) proposed the use of effective heat units to prediet the best time to harvest.

Materials and Methods

Experiments I, II, and III were designed to collect information on plant fruit and kernel characteristics at intervals during fruit development and maturation. Planting rates were 3-5 viable seed per foot in rows spaced 40 inches apart. Experiment I and II were grown in a Vanoss fine sandy loam soil on the Agronomy Research Station near Perkins in 1964 and 1965. respectively. Experiment III was grown in a Stidham sandy loam soil on the Peanut Research Station near Stratford.

Experiment I

Argentine peanuts were planted on May 26, 1964. Approximately, 2.5 inches of supplemental water were applied on July 15 and 2.0 inches on August 4 and 5. Five plants were pulled at random on Monday, Wednesday and Friday starting August 17 or 83 days after planting and continued at regular intervals to November 2 or 160 days after planting. Three plants each were used to determine the percentage of mature and immature, and mean individual kernel weight for some of the harvest dates.

Experiment II

Argentine peanuts were planted on May 25, 1965. Approximately 4.5 inches of supplemeutal water were applied to the plot area on July 26-27 and August 6-7. Twenty plants were randomly pulled starting on August 28 or 95 days after planting and proceeding at weekly intervals to October 23 or 151 days after planting. Ten of the plants were used to determine the plant and fruit weights and the number of fruit. The remaining 10 plants were used to determine the percentage of mature, intermediate, and immature kernels, the number of pegs and pops and the MIKW.

Experiment III

Dixie Spanish peanuts were planted on May 22, 1965. Twenty plants were harvested starting September 10 or 111 days after planting, and continued at weekly intervals to October 15 or 146 days after planting. The plants were used to obtain information comparable to that obtained in Experiment II. Yield, grade, and seed size data were also obtained for each of the six harvest dates in this study (2).

Results and Discussion

Climatic Conditions

The rainfall from May 1 through October 27 was 19.33, 23.34, and 15.44 inches for Experiments I, II, and III, respectively. Of the 18 ten-day intervals between May 1 and October 27, there were 9, 8 and 6 that had less than 0.5 inch of rain for Experiments I, II and III, respectively.

There were 31, 27 and 21 days respectively, for Experiments I, II and III where the daily minimum temperatures were below 55° F. during October.

Plant Weight

There were significant plant weight increases among harvest dates for Experiments I and II but not for Experiment III (Table 1, 2, 3 and Figure 1). Mean plant weights were highest between 125 and 134 days after planting in Experiment I aud for 144 and 151 days after planting in Experiment II. The latter closely resembles a normal growth curve.

Fruit Weights

There were significant increases in fruit weights among the various harvest dates for Experiment I and II but not for Experiment III (Tables 1, 2, 3 and Figure 2). The mean weights of the fruit from individual plants were highest between 125 and 134 days after planting for Experiment I and 137 and 151 days after planting for Experiment II. The mean

Table 1. Mean plant and fruit weights (oven-dry), number fruit formed, percentage mature and immature fruit, number pops and MIKW for Experiment I, Perkins, 1964.

Harvest Date	No. Days After Planting	Plant Wt. (gms.)	Fruit Wt. (gms.)	No. Fruit	Mat. (%)	Imm. (%)	No. Pops	MIKW (gms.)			
								Mat.	Int.	Imm.	Mean
8-17	83	40.5	5.3								
8-19	85	44.0	6.1								
8-21	87	45.3	6.8								
8-24	90	48.7	11.0								
8-26	92	47.2	10.9								
8-28	94	48.4	14.6								
8-31	97	62.6	13.9								
9- 2	99	63.5	20.8								
9- 4	101	54.1	17.1								
9- 7	104	61.0	22.5								
9- 9	106	86.9	33.4								
9-11	108	78.5	30.8								
9-14	111	80.8	29.1								
9-16	113	67.3	33.8	37	16.0	84.0	4.0				
9-18	115	71.8	38.5	40	18.1	81.9	16.0				
9-21	118	68.3	39.1								
9-23	120	75.0	46.5								
9-25	122	79.1	53.6	67	22.8	77.2	8.0				
9-28	125	121.2	78.2								
9-30	127	117.4	85.2								
10- 2	129	103.7	73.3	71	73.0	27.1	13.0				
10- 5	132	96.9	71.6								
10- 7	134	117.7	77.2								
10- 9	136	73.0	75.1	74	69.2	30.8	3.0	.35	.35	.23	.31
10-12	139	101.1	79.1								
10-14	141	77.1	71.3								
10-16	143	79.3	67.0	64	66.0	33.8	9.0				
10-19	146	81.5	63.3								
10-21	148	81.1	63.2								
10-23	150	60.7	65.3	64	58.5	41.5	2.0	.38	.39	.31	.36
10-26	153	66.5	63.6								
10-28	155	70.5	62.0								
10-30	157	68.3	70.6	77	24.0	76.0	3.0	.35	.35	.32	.34
11- 2	160			71	42.8	57.2	2.0	.33	.35	.34	.34
	MEAN	73.9	45.4	62.8	43.4	56.6	6.7	.35	.36	.30	.34
	LSD.05	24.8	14.7	23.8							
	C.V. (%)	27.1	26.0	23.6							

Table 2. Mean plant and fruit weights (oven-dry), number fruit formed, percentage of mature and immature fruit, percentage of pops and pegs per plant and MIKW for Experiment II, Perkins, 1965.

Harvest Date	No. Days After Planting	Plant Wt. (gms.)	Fruit Wt. (gms.)	No. Fruit	Fruit		Pops (%)	Pegs (%)	MIKW (gms.)			
					Mat.[a] (%)	Imm. (%)			Mat.	Int.	Imm.	Mean
8-28	95	109.6	32.0	49.7	40.3	59.7	10.6	70.0	.30	.25	.22	.26
9- 4	102	120.0	38.4	82.8	47.7	52.2	15.0	62.2	.36	.33	.27	.32
9-11	109	121.1	48.1	81.9	48.9	51.0	14.1	57.8	.37	.29	.25	.30
9-18	116	122.8	68.9	125.1	41.6	58.4	10.4	53.5	.40	.34	.28	.34
9-25	123	126.1	77.9	150.9	57.4	42.6	9.9	47.8	.43	.38	.28	.36
10- 2	130	126.5	60.2	110.6	63.9	34.1	6.9	50.9	.47	.40	.30	.39
10- 9	137	138.5	93.1	119.9	64.5	35.7	8.2	49.1	.46	.38	.35	.40
10-16	144	170.5	79.1	145.5	65.2	33.8	7.2	46.5	.43	.39	.25	.36
10-23	151	170.6	120.4	156.7	70.2	29.8	6.0	47.2	.43	.39	.26	.36
	MEAN	134.0	68.8	113.6	52.5	47.5	9.8	53.9	.41	.35	.27	.34
	LSD.05	42.1	40.2	12.1	14.5	18.6						
	C.V. (%)	35.5	24.4	62.3	44.8	44.2						

[a]Percentage of mature fruit based on the number of fruit with light to dark interior pericarp color.

Table 3. Mean plant and fruit weight (oven-dry), number fruit formed, percentage of mature and immature fruit, percentage of pops and pegs per plant and MIKW for Dixie Spanish in Experiment III, Stratford, 1965.

Harvest Date	No. Days From Planting	Plant Weight (gms.)	Fruit Weight (gms.)	No. Fruit	Fruit		Pops (%)	Pegs (%)	MIKW (gms.)			
					Mat. (%)	Imm. (%)			Mat.	Int.	Imm.	Mean
9-10	111	106.4	37.6	48.0	39.4	60.1	12.4	52.7	.35	.33	.34	.34
9-17	118	86.7	53.4	39.9	44.7	55.4	9.8	58.2	.35	.39	.29	.34
9-24	125	91.1	51.3	41.4	59.6	40.3	5.5	51.9	.32	.38	.33	.34
10- 1	132	87.5	44.9	41.1	55.3	44.8	11.0	51.4	.35	.42	.34	.37
10- 8	139	80.1	47.9	38.3	59.8	40.2	11.2	48.9	.43	.39	.29	.37
10-15	146	102.9	55.1	56.8	54.9	44.4	8.8	54.1	.37	.40	.36	.38
	MEAN	92.4	48.4	44.2	52.5	47.6	9.8	52.9	.36	.38	.32	.36
	LSD.05	N.S.	N.S.	9.3								
	C.V. (%)	41.0	49.1	63.0								

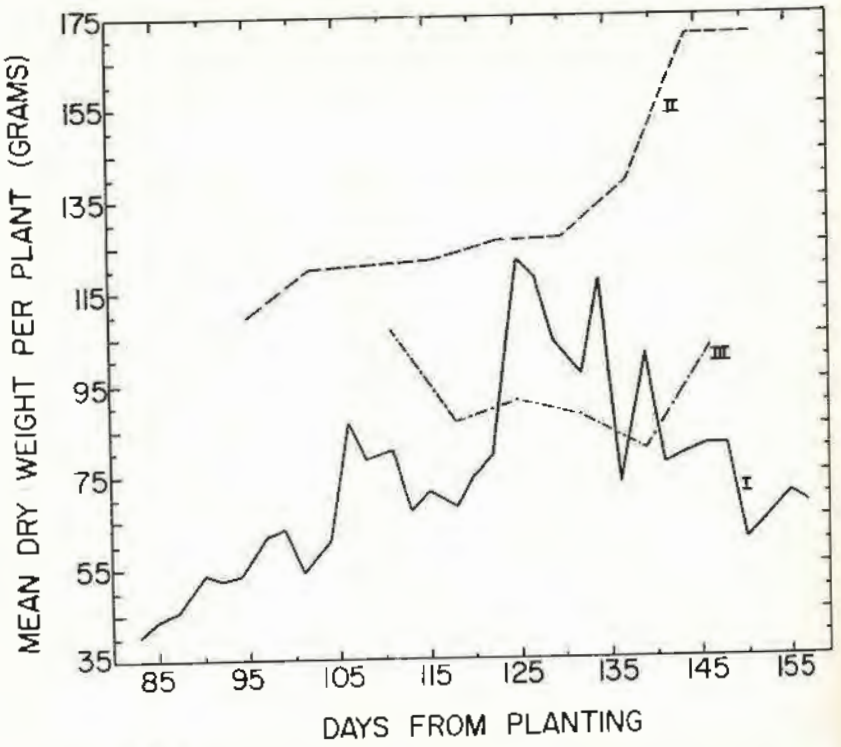


Figure 1. Mean dry weight per plant at various harvest dates for three experiments conducted in 1964 and 1965.

weights for the plants and fruits reached a maximum level at about the same number of days after planting.

Fruit Per Plant

The mean number of fruit per plant differed significantly among harvest dates in each of the three experiments (Tables 1, 2, 3 and Figure 3). The highest number of fruits per plants occurred 157, 151 and 146 days after planting, respectively, for Experiments I, II and III. The mean number of fruits per plant was 62.8, 113.6 and 63.0, respectively, for Experiments I, II and III. The larger number of fruit per plant in Experiment II was attributed to a wider spacing between plants.

Maturity Data

Pigmentation of the internal pericarp was used as basis for classifying the fruit as mature, intermediate or immature. Fruit with a dark pigmentation of the interior pericarp were considered mature, fruit with a white interior pericarp were classed as immature, and those between

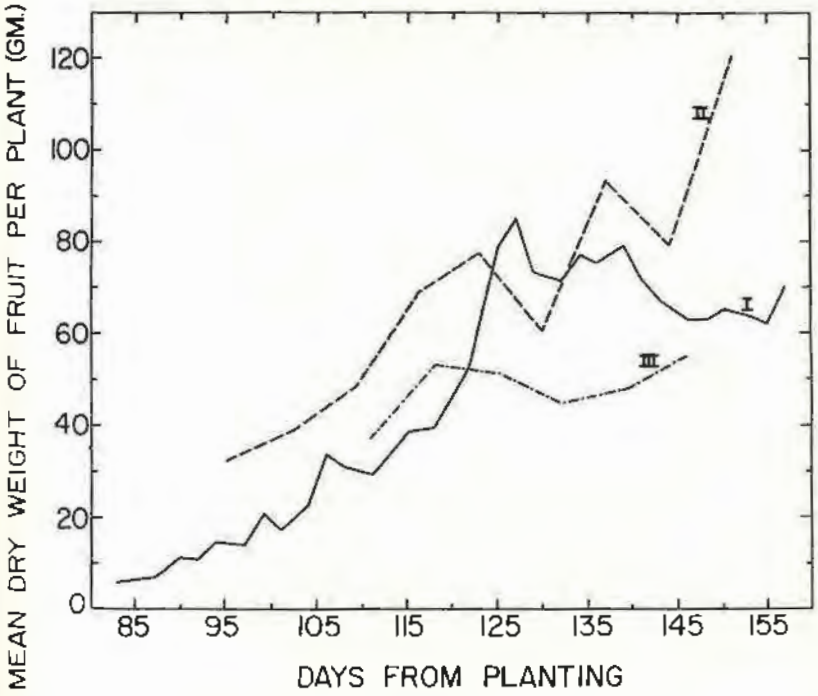


Figure 2. Mean dry weight of fruit per plant at various harvest dates for three experiments conducted in 1964 and 1965.

these extremes were intermediates. Since, the kernels from mature and intermediate fruits behaved similarly in subsequent chemical and organoleptic tests they are both considered mature in this discussion.

Mature vs Immature - The highest percentages of mature fruit per plant occurred 129, 151, and 139 days after planting with 70.3, 70.2, and 59.8 percent, respectively for the three Experiments (Tables 1, 2, 3, and Figure 4). Conversely, the lowest percentage of immature fruit per plant occurred on the same date.

MIKW - Kernels from mature, intermediate and immature fruits were separated into two size groups using the 15/16 x ¾-inch slotted screen. Those riding the 15/64-inch screen were designated as large while those passing through the 15/64-inch screen were designated as small. The oven-dry weight of the kernels were determined and the mean individual kernel weights were calculated for each Experiment (Tables 1, 2, 3 and Figure 6). In Experiment I the MIKW was highest 150 days after planting for the kernels from mature and intermediate fruits. The immature kernels were slightly smaller and the MIKW reached its largest size 160 days after planting.

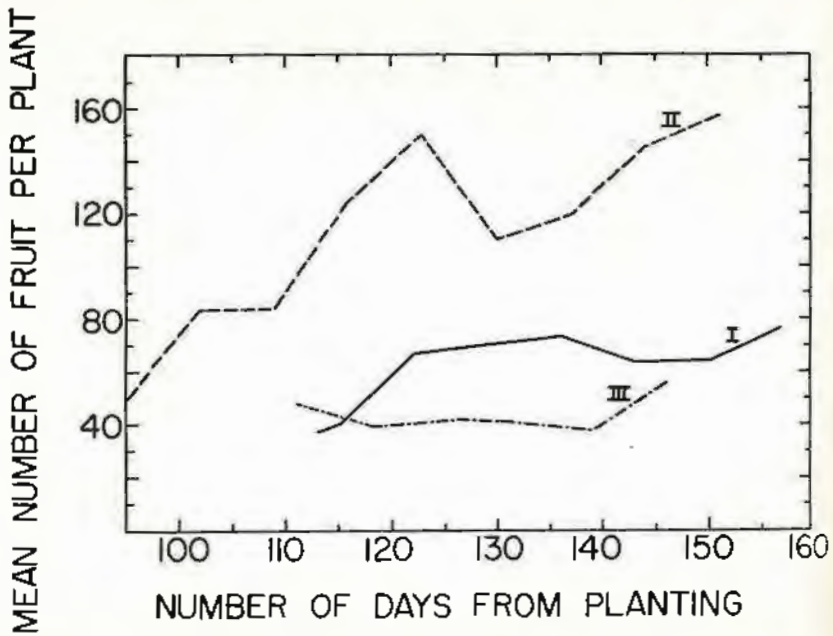


Figure 3. Mean number of fruit per plant at various harvest dates for three experiments conducted in 1964 and 1965.

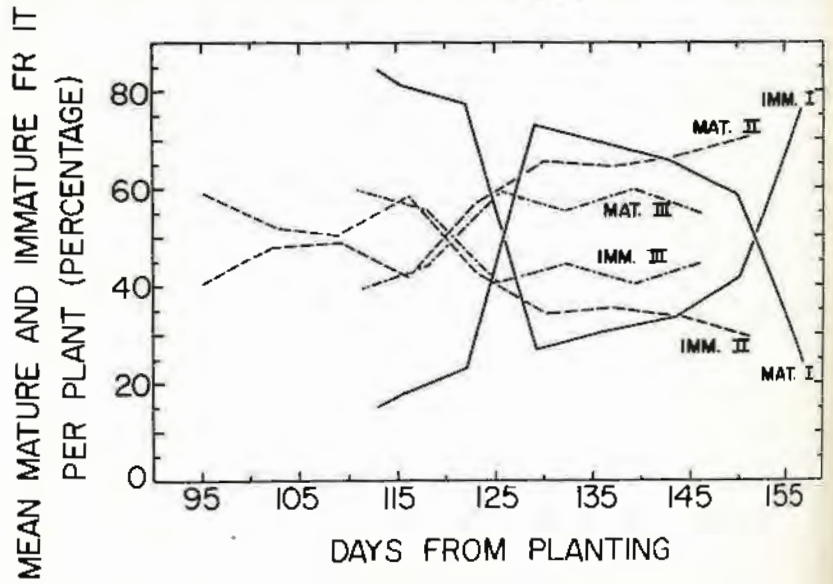


Figure 4. Mean percentage of mature and immature fruit per plant at various harvest dates for three experiments conducted in 1964 and 1965.

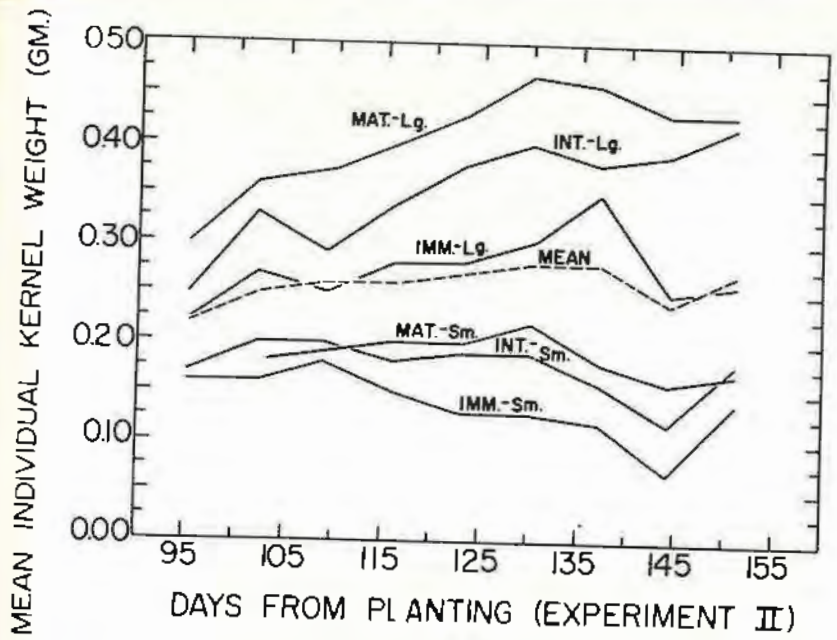


Figure 5. Mean individual kernel weight for large and small kernels of three maturity groups at various harvest dates in experiment II, Perkins, 1965.

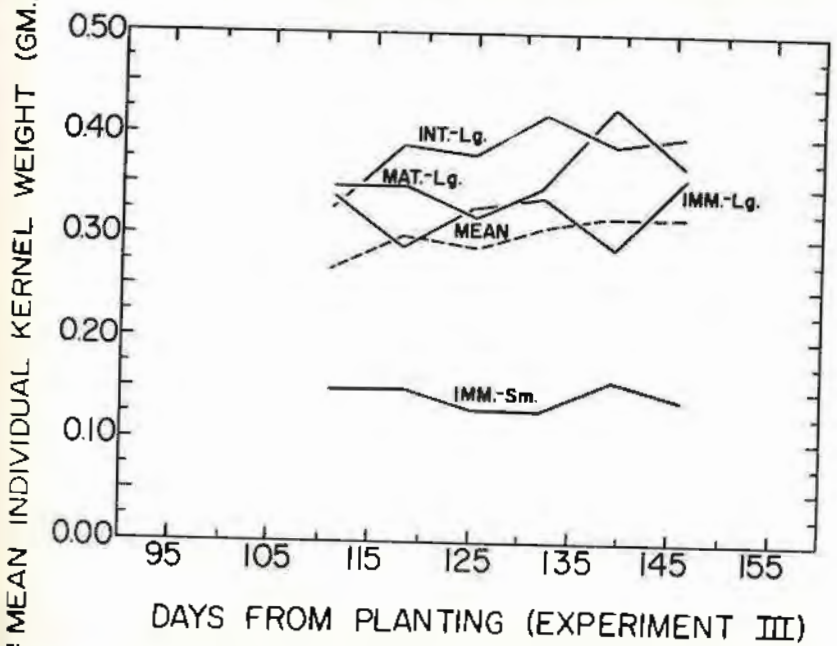


Figure 6. Mean individual kernel weight for large and small kernels of three maturity groups at various harvest dates in experiment III, Stratford, 1965.

In Experiment II the MIKW was highest 130 days after planting for both mature and intermediate kernels. The immature kernels were heaviest 137 days after planting.

In Experiment III the MIKW was highest 139, 132 and 146 days after plantings for the mature, intermediate, and immature kernels, respectively.

Barrs (1) reported that MIKW could be used to estimate maturity and that each variety should reach a constant value. Argentine in Experiment I reached the MIKW of 0.36 gram 150 days after planting but required only 137 days to reach 0.40 gram in Experiment II. If the maturity groups are disregarded the date when the highest MIKW was obtained in Experiment II and III does not agree with the date when maximum fruits were obtained.

Yield and Grade

The mean yield, grade and grams per 100 seed are shown in Table 4 and Figure 7.

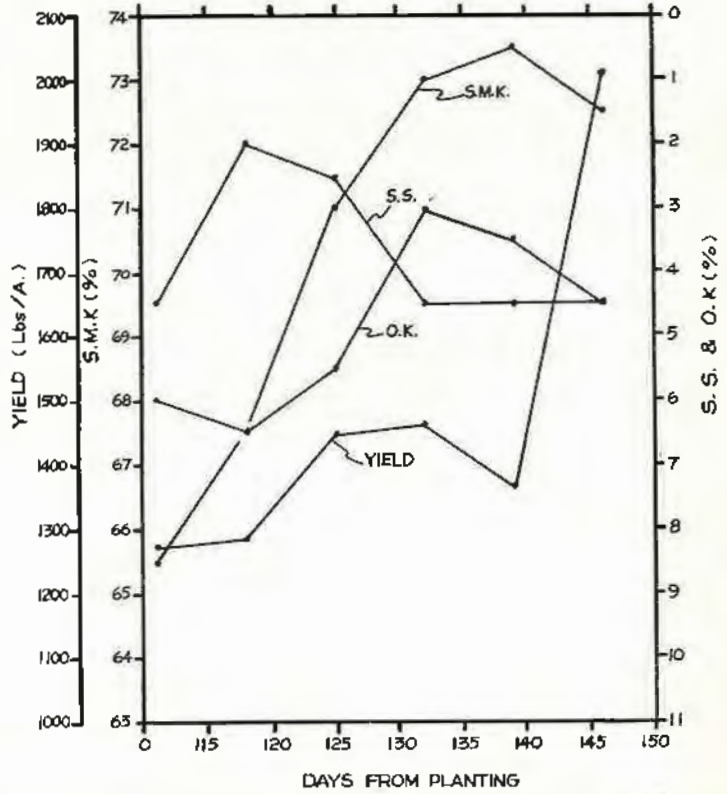


Figure 7. Mean yield, sound mature kernels (SMK), Sound splits (SS) and other kernels (OK) at six harvest dates in experiment III, Stratford, 1965.

Table 4. Mean yield and grade for Dixie Spanish harvested at six dates, Stratford, 1965.

Harvest Date	Days After Planting	Yield (lbs/A)	Gross Returns Per Acre	SMK (%)	SS (%)	OK (%)	Damaged Kernels (%)	Grms. Per 100 seed
9-10	111	1275	135.86	65.5	4.5	6.0	0.0	45.8
9-17	118	1284	142.22	67.5	2.0	6.5	0.0	47.9
9-24	125	1447	164.48	71.0	2.5	5.5	0.0	46.2
10- 1	132	1463	170.10	73.0	4.5	3.0	1.5	49.1
10- 8	139	1365	160.25	73.5	4.5	3.5	1.0	50.6
10-15	146	2011	233.64	72.5	4.5	4.5	0.5	50.2
MEAN		1474		70.5	3.8	4.8	0.5	48.3
LSD.05		407		6.7	2.5	N.S.	N.S.	N.S.
C.V. (%)		20.9		2.2	15.6	18.6	116.6	6.0

Yields increased gradually for the first four harvest dates but only the last harvest date (146 days after planting) was significantly higher than earlier harvest dates.

The mean percentages of sound mature kernels (SMK) and sound splits (SS) differed significantly among harvest dates. The SMK increased slightly for each of the first five harvest dates but only the first harvest date (111 after planting) had significantly lower SMK than the last three harvest dates (132, 139 and 146 days after planting). The percentage of sound splits obtained on the second harvest date (118 days after planting) was significantly less than each of the other harvest dates except those harvested September 24 (125 days after planting).

The mean percentages of other kernels, damaged kernels and grams per 100 seed did not differ significantly.

Summary

These data indicate that immature peanuts are undoubtedly present in any bulk sample. Therefore, until a procedure can be developed to genetically or mechanically eliminate the immatures the whole sample should be handled during harvesting and curing so as to produce maximum quality of the immature portion.

LITERATURE CITED

1. Barrs, H. D. The relation between kernel development and time of harvesting peanuts at Katherine, N. T. Aust. Jour. Exp. Agri. and An. Hus. 2:106-109. 1962.
2. Collins, John Jerry. The Influence of Time of Harvesting Dixie Spanish Peanuts on Maturity, Yield and Grade. Unpubl. Master's Thesis. pp. 1-47. June, 1966.
3. Garren, Kenneth H. Relation of diseases and disease control practices to quality of raw peanuts for specific end uses. Proc. Peanut Res. Conference. pp. 34-42. Feb., 1957.
4. Higgins, B. B. Relation of breeding and varieties to quality for specific uses. Proc. Peanut Research Conf. 13-21. 1957.
5. Holley, K. T. Chemical studies of peanut curing - quality relationships. Proc. P.I.W.G.
6. Mills, Wm. T. Effective heat units as a system for predicting optimum time to harvest peanuts. Amer. Soc. Agri. Engr. Mtg. pp. 1-4, 1961.
7. Teter, Norman C. Physical and pathological factors affecting quality of peanuts as influenced by curing. Proc. Peanut Res. Conference. pp. 54-62. Feb., 1957.
8. Toole, Vivian K., W. K. Bailey, and E. H. Toole. Factors influencing dormancy of peanut seeds. Plant Physiol. 39:822-832. 1964.
9. Watson, S. A. The Importance of Quality Seed in the Manufacture of Finished Products of Highest Qnality. Annual Meeting of the Oklahoma Crop Improvement Association. pp. 1-7. January, 1964.

Indexing the Maturation of Varietal and Segregating Populations of Virginia Type Peanuts[1]

D. A. Emery, C. L. Gnpton and R. O. Hexem
Professor of Crop Science, N. C. State University; Graduate Research Assistant in Crop Science, N. C. State University; Assistant Professor of Agronomy, Arkansas State College, respectively.

Desirable flavor and aroma of the end product is the ultimate goal of the entire peanut industry. Immature peanuts have frequently been associated with off-flavors. Since the Virginia type peanut harvest includes a wide range of mature and maturing kernels, it is important that effective and objective maturity indices be developed.

Indexing Varietal Maturation

The Virginia type peanut has an indeterminate growth habit. To standardize the various lots of fruit for indexing purposes, consecutive pegs on a prominent branch of each of 60 plants (per variety) were tagged as they penetrated the soil on July 15, and 26, 1963. The test was seeded May 6 at the Upper Coastal Plain Research Station near Rocky Mount, North Carolina. Twenty of the plants were dug on September 20, October 2, and October 17, respectively. Using this procedure nine different lots of fruit (pegging July 15, 26, and remainder dug on three harvest dates) of known origin were available from each of nine varieties for further study.

Among the several subjective and objective methods used to differentiate the maturity of farmer's stock peanuts at harvest, measurements of oil pigmentation were found to be the most effective. High concentrations of pigments were shown to be associated with immaturity when fruit were cured rapidly over forced air at room temperature. Pigments were not present, even in immature kernals, if the fruit were cured by the traditional stackpole method.

The relative amounts of pigment in the oil were determined by recording the light in 455 mu wave length range transmitted through the pressed oil. Mineral oil standardized as 100 percent transmittance on a Spectronic 20 Colorimeter was used as a check. The traditional maturity indices of internal pod color, seed coat smoothness and average kernal weights did not always allow distinctions in maturity to be made among the fruit derived from designated growth periods. The maturities of the fruit derived from the nine growth periods of variety

[1]This work was supported in part by the NSF Program of Research Participation for College Science Teachers and the North Carolina Peanut Grower's Association.

NC2 were, however, clearly and consistently differentiated by this method (Table 1) involving oil pigmentation.

The accuracy of the oil method in separating maturity classes of fruit initiated in three pegging periods is shown in Table 2. Large and highly significant statistical differences were determined among the three pegging dates. Significant differences in the maturation of the nine peanut varieties as indexed by the oil method were also found.

To determine specifically which growth periods were responsible for varietal differences in maturity at harvest, the variances among varieties within individual growth periods were analyzed (Table 3).

Table 1. A comparison of four maturity indices applied to fruit derived from standarized growth periods, variety NC2.

Date of Pegging	Date of Harvest	Internal Color of Pod % Brown	Smoothness of Seed Coat % Smooth	Wt. of Med. and Extra Large Kernels Wt. Avg.- Grams	Light Transmittance of Pressed Oil (455 mu), % of Mineral Oil Standard
Before July 15	Sept. 20	37	76	.75	80
July 15-26	Sept. 20	56	82	.64	60
After July 26	Sept. 20	40	45	.58	39
Before July 15	Oct. 2	66	79	.72	86
July 15-26	Oct. 2	48	81	.72	73
After July 26	Oct. 2	30	69	.61	52
Before July 15	Oct. 17	84	86	.74	90
July 15-26	Oct. 17	79	85	.74	83
After July 26	Oct. 17	33	81	.67	70

Table 2. Analyses of variance of light transmittance of oil, varieties, and pegging dates (within digging dates).

Source	d.f.	m.s. Dig. 1	m.s. Dig. 2	m.s. Dig. 3
Varieties	8	290.0**	255.8*	72.1*
Error a	8	19.0	70.7	13.4
Pegging Dates	2	3608.0**	4878.0**	3309.0**
Var. x Peg. Dates	16	75.6	72.4**	5.4
Error b	18	42.8	13.6	33.7

*Significant at 5% level.
**Significant at 1% level.

Differences in maturation of the nine varieties were observed most frequently in the shorter growth periods, i.e., fruit harvested early on September 20 or fruit pegged after July 26. Using the error mean squares of the nine analyses of variance in Table 3 to determine standard errors, Duncan's New Multiple Range Test was applied to the means

Table 3. Analyses of variance of light transmittance of oil, varieties (within digging and pegging dates).

Digging	Source	m.s. Pegging 1	m.s. Pegging 2	m.s. Pegging 3
1	Replicate	128.00**	896.05**	1058.00**
	Varieties	57.26*	141.50**	242.18*
	Error	9.62	18.30	41.38
2	Replicates	26.89	128.00	320.89*
	Varieties	43.12	117.68	239.88**
	Error	19.01	42.38	29.76
3	Replicates	43.55*	8.00	72.00*
	Varieties	12.12	25.00*	95.75**
	Error	5.18	6.75	12.00

*Significant at 5% level.
**Significant at 1% level.

of six well known commercial varieties of Virginia type peanuts, Tables 4, 5, and 6. Varieties included two Virginia bunch types, NC2 and Ga 119-20; three Virginia runner types, Va 61R, Va 56R and Florigiant; and the intermediate NC5.

The results are summarized according to harvest date.

Early Harvest September 20—The varieties NC2, Va 61R and Florigiant all appeared to be comparatively more mature than NC5, Ga 119-20 or Va 56R when the crop was harvested early. Va 61R was among the top two in mean light transmittance readings for all three pegging dates. Ga 119-20 was the least mature of the six varieties examined in the harvest.

Intermediate Harvest October 2—When the crop was harvested later in the fall the variety NC2 received higher maturity ratings than the other five varieties regardless of the time of pegging. Statistically significant differences in maturity were recorded between NC2 and Va 56R, Ga 119-20 and NC5 when fruit were set earlier than July 15. Fruit set between July 15 and 26 allowed the maturity of NC2 to be distinguished from that of Va 56R and Ga 119-20. NC2 and Florigiant were found to have significantly higher maturity ratings than the other four varieties when fruit was pegged after July 26.

Late Harvest October 17—Fruit pegged prior to July 15 in North Carolina and harvested as late as October 17 (at least in 1963) produced fruit of comparable maturity on all six varieties. In contrast NC2 tended to produce significantly more mature fruit than Ga 119-20, Va 56R, Va 61R, Florigiant or NC5 when the fruit was pegged between July 15 and 26. Similarly the fruit pegged after July 26 had higher maturity ratings in Florigiant or NC2 varieties than the other four mentioned. The latter may explain why NC2 and Florigiant frequently mature a good crop of peanuts late in the season after drought has seriously limited plant growth in the mid-summer months.

Table 4. Duncan's new multiple range test of mean light transmittance of oil. Six varieties; three pegging periods; dug Sept. 20.

	Varietal Means[a]					
1. *Pegged by July 15*	Ga. 119-20	NC5	Va 56R	Florigiant	Va 61R	NC2
	61.5	72.0	76.5	77.0	77.5	79.5
2. *Pegged July 15-26*	Ga 119-20	Va 56R	NC5	NC2	Florigiant	Va 61R
	37.0	51.5	53.5	59.5	61.5	65.0
3. *Pegged after July 26*	Ga 119-20	NC2	Va 56R	NC5	Va 61R	Florigiant
	28.0	38.5	38.5	49.0	51.5	52.5

[a]Any two means not underscored by the same line are significantly different from each other at the 5% level.

Table 5. Duncan's new multiple range test of mean light transmittance of oil. Six varieties; three pegging periods; dug October 2.

	Varietal Means[a]					
1. *Pegged by July 15*	Va 56R	Ga 119-20	NC5	Va 61R	Florigiant	NC2
	74.5	75.0	75.0	80.5	84.0	85.5
2. *Pegged July 15-26*	Va 56R	Ga 119-20	NC5	Va 61R	Florigiant	NC2
	46.5	49.0	57.5	58.0	60.5	72.5
3. *Pegged after July 26*	Ga 119-20	Va 56R	Va 61R	NC5	Florigiant	NC2
	31.0	31.5	41.0	44.0	46.0	52.0

[a]Any two means not underscored by the same line are significantly different from each other at the 5% level.

Table 6. Duncan's new multiple range test of mean light transmittance of oil. Six varieties; three pegging periods; dug October 17.

	Varietal Means[a]					
1. *Pegged by July 15*	Ga 119-20	Va 56R	Va 61R	NC5	Florigiant	NC2
	84.5	85.5	86.0	87.5	90.0	90.0
2. *Pegged July 15-26*	NC5	Florigiant	Va 56R	Va 61R	Ga 119-20	NC2
	70.5	72.0	74.5	76.0	76.5	83.0
3. *Pegged after July 26*	Va 56R	NC5	Ga 119-20	Va 61R	Florigiant	NC2
	49.0	50.5	56.0	57.0	66.5	69.5

[a]Any two means not underscored by the same line are significantly different from each other at the 5% level.

In summary NC2, Florigiant and Va 61R produced more mature fruit than Ga 119-20, NC5 or Va 56R in the season described. Va 61R and Florigiant matured particularly well in the early harvested crop. NC2 contributed high proportions of mature fruit to the intermediate harvest and both NC2 and Florigiant matured comparatively well in the late harvest. Ga 119-20 and Va 56R did not have high oil readings in any of the nine growth periods.

Indexing Field Maturation of a Single Variety

To utilize the oil pigmentation as a selection tool in a breeding program it was realized that the tagging of pegs, a slow, laborious, and costly procedure, would have to be circumvented. The growth habit and branching pattern of the Virginia type peanut is well known. By carefully studying the flowering and pegging patterns at previously identified reprodnctive positions on the cotyledonary laterals Gupton (unpublished) determined that peg placement and branching pattern were highly correlated. Thus the need for tagging was eliminated.

The first pegs to enter the ground in July were found to arise from nine specific and easily recognized positions on the lateral. Identification of these positions has given the researcher a standardized means of comparing fruit from genotype to genotype, location to location or season to season.

In 1965 Hexem (unpublished) used transverse cuttings of kernels derived from these nine positions to follow field maturation patterns of NC2 (Table 7). Using kernel diameter in percent of fruit diameter as an indicator of field maturity at the standardized positions described, five different fields of NC2 planted at weekly intervals were successfully (with one exception) indexed. This index reqniring only 15 plants gave the farmer an opportunity to assess the progress of his crop from field to field or season to season 40 to 50 days prior to harvest.

Indexing Maturity in Divergent Geographic Areas

Not only may this method be used to compare different lots of the same variety in one location but it may also be used to evaluate environmental effects on different varieties grown in several geographical areas. Through the cooperation of A. J. Norden, R. O. Hammons, and M. W. Alexander 15 late generation hybrids and four varietal checks were grown in Florida, Georgia, North Carolina, and Virginia in 1965. Each were indexed for maturity by the transverse cutting method involving the nine standardized positions using maximum maturity of NC2 as a check. Maturity ratings for each of the genotypes grown in North Carolina were found to be significantly correlated with similar ratings in Florida, Georgia and Virginia (Table 8).

The oil pigmentation-branching pattern relationships are currently under study.

Table 7. Maturity rating of variety NC2 on transverse cuttings of the basal kernel; nine plant positions, Northhampton County, N. C. August 10, 1965.

Field	Planting Date	No. Kernels	Avg. Kernel Diameter*
1	April 15	75	68.5
2	April 23	75	61.9
3	April 30	55	59.9
4	May 8	63	48.4
5	May 15	69	52.9

*In percent of fruit diameter.

Table 8. Correlations of maturity indices applied to 15 hybrids and four varieties of peanuts grown in four geographic areas.

Range of Maturity Index	State	Correlation Coefficients N.C.	Ga.	Fla.
(77.9-86.5)	Va.	+0.8743**	+0.7816**	+0.8720**
(72.6-85.3)	N.C.		+0.6724**	+0.8139**
(75.7-85.4)	Ga.			+0.7598**
(74.1-84.7)	Fla.			

New Production Tools and Techniques

James L. Shepherd, *Head*
Department of Agricultural Engineering
University of Georgia Coastal Plain Experiment Station

Complete mechanization of peanut production, harvesting and curing is virtually a common-practice reality in Georgia.

The "package plan" of systematic procedure in the application of tools and techniques is rapidly gaining in adoption by peanut producers. Recent and current engineering research and development effort features the effecting of refinements and additions to the "plan".

Some newly developed production tools which contribnte very significantly toward attaining optimum approach are: (1) A multi-bottom reversible (roll-over) plow equipped with concave disc coulters for efficiently burying crop residue in turning soil for peannt production; (2) A hooded sweep device for sub-surface application of selective herbicides; (3) A combination tine and knife unit for breaking soil clods and injecting herbicides; (4) A gage shoe; (5) A "quick-tatch" clamp for mounting tools to cultivator frames.

Only one make of multi-bottom reversible type moldboard plows was suitable for equipping with concave disc coulters. Special fitting was required, but after mounting and setting, the coulters performed well

Figure 1. Reversible plow with concave disc coulters adapted to serve all bottoms while functioning.

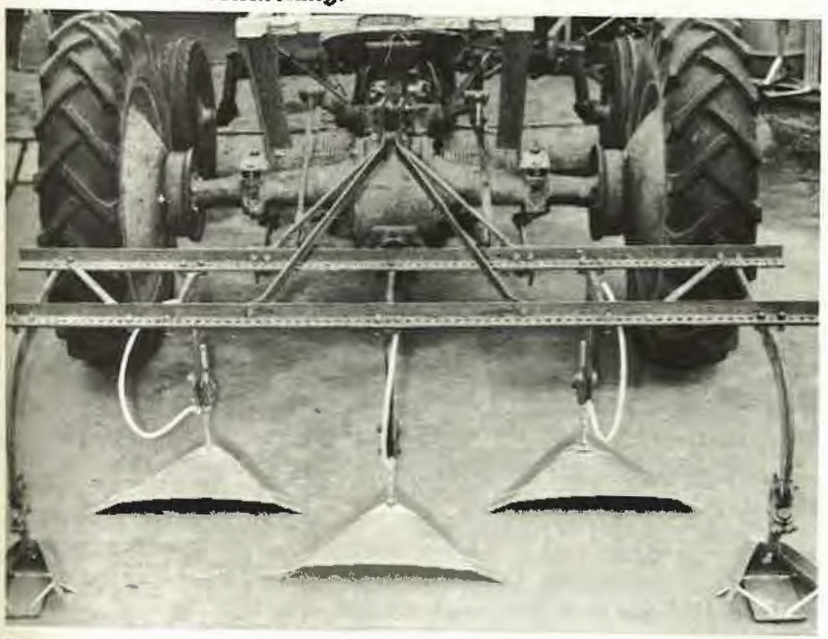


Figure 2. Subsurface applicator sweeps mounted for complete seedbed coverage.

Figure 3. Combination tool for breaking clods, injecting herbicides and smoothing seedbed. Gage shoes mounted for depth control and wheel furrow scoring.

the function of aiding in the efficient burial of residue litter. This achievement is considered a breakthrough, as precision farming in the foreseeable future indicates imperatively the important role of functional principles which the reversible plow possesses.

Intensive effort in the control of nutsedge (nnt grass) has produced some very promising new tools and techniques for applying selective herbicides to the soil. The sweep applicator was developed in two widths for effective subsurface spray of 16″ and 20″ bands. It functions best when operating at 3″ to 5″ depth in freshly prepared and settled soil which is free of litter to the operating depth. A combination of sweeps and knife-type injectors function well in attaining full field treatment of all bed and wheel track areas. (drawings are available).

The unit for the simultaneous breaking of soil clods and injecting of herbicides functions well in the row marking and bed forming operation close behind land turning. Three rows of staggered tines, with effective coverage of 1½″ for each tine, comb the bed area to a depth of 3″ to 4″. Herbicide injection in the bed is by orifice adapters and tubes attached to backs of tines in the front row. Knife type injector blades with depth

adjustability apply the soil treatment to the wheel track furrows. (drawings are available).

The gage shoe serves as a simple means of regulating traveling tool position for consistency in depth relative to the soil surface. The unit features a steel skid plate and a rear mounted scoring chisel with optional position adjustability. (drawings are available).

The "quick-tatch" clamp is a very good time and labor saver in the normal use of production tools which involve the Pittsburgh type cultivator frame. The design of the unit eliminates the long and troublesome task of removing and replacing several fine-thread bolts when tool mountings must be changed. With the clamp the moving of each cultivator foot (tine) requires only the loosening and retightening of two set screws. (Early commercial manufacture and supply of the clamp is anticipated.)

Research Studies on Drying Farmers Stock Peanuts

By Reed S. Hutchison
Agricultural Engineer
Handling and Facilities Research Branch
Transportation and Facilities Research Division
ARS, USDA, Albany, Georgia

Studies during the past four seasons by the Transportation and Facilities Research Division of the Agricultural Research Service, U. S. Department of Agriculture have been directed toward faster drying of peanuts with minimum damage to the market quality.

With the rapid harvesting methods now in use, drying facilities are often overtaxed, and undried peanuts may be held in bulk for as much as 24 hours, or longer, before artificial drying is started. Very often, commonly used drying equipment does not uniformly distribute the heated air, and peanuts with unsafe storage moisture contents may be found after the artificial drying process has been terminated.

With the most common drying method, heated air (95 to 100°F.) is moved vertically through beds of peanuts in depths up to four feet (Figure 1). Heated air is applied continuously until peanuts at the top of the bed, where the air leaves, are at ten percent moisture content or lower. Very often this drying procedure results in overdrying the peanuts at the bottom of the bed, where the air enters. Table 1 shows the difference in moisture content of peanuts at the top and bottom of the bed when the heated air enters at the bottom and moves up through the bed. As shown in Table 2, overdrying results in excessive splitting of kernels and skin slippage.

The relatively slow drying rate with conventional dryers (20 to 30 hours to reduce the moisture from 20-25 percent to 10 percent) may be

conducive to the growth of molds and the production of mycotoxins. In deep beds, such as are used with conventional drying, conditions favorable for mold growth may be of sufficient length to be a major problem. Faster drying reduces the period of susceptibility to mold production and may eliminate much of the problem with mycotoxins.

In the 1962 drying season a method that simulated sack drying was tested. This method consisted of alternately applying the heated air from the top of the column and from the bottom (Figure 2, Method A). The heated air was applied from each direction for two hours for some tests and one hour for others. Application of the heated air in this manner reduced the length of time peanuts were continuously exposed to the heated air and provided more uniform drying. The difference in moisture content between peanuts at the top and bottom is shown in Table 3.

This method made possible the use of higher drying air temperatures and a faster moisture removal rate, with little or no increase in damage to milling quality over that caused by the common method. The one-hour exposure period caused less splitting than did the two-hour period. Organoleptic evaluation of peanuts from each drying test failed to show off-flavor as a result of using higher temperatures (125, 130, 135, and 140°) with this method. Table 4 shows a comparison of the percent of sound splits as shown by the official grade for ambient air-dried peanuts and peanuts dried by two-direction drying.

In 1963 two additional drying methods were tested. The main feature of both methods was a further limitation on the length of time peanuts were continuously exposed to heated air.

The first method was similar to the method used in 1962 except that a cooling and tempering period of one hour followed each hour of exposure to heated air (Figure 3, Method B). The cooling and tempering period consisted of moving ambient air through the peanuts in the same direction as the previous heated air treatment. Heating and cooling the peanuts in this manner had the effect of keeping the heat from each exposure period in the column of peanuts for a maximum four-hour period. However, the peanuts in any section of the bin were not exposed to heat for a continuous period of more than one hour.

The second method tested in 1963 differed from the first in that the air used for the cooling and tempering period was in the opposite direction from the air used for the previous heating treatment (Figure 4, Method C). Cooling with air movement in the opposite direction from that used in the previous heating period had the effect of keeping the heat in the peanut column for no more than two hours.

Results of the tests with these methods indicated a decided improvement over the method without the cooling and tempering period.

A comparison of the out-turn of splits with three drying methods is shown in Table 5. The peanuts from each drying test were shelled, identity preserved, in the U. S. Department of Agriculture's Experimental Shelling Plant.

Table 1. Moisture contents of peanuts at the top and bottom of the bed when dried in a wagon box dryer.

Test No.	Depth of Bed	Initial Moisture Content	Moisture Content After Artificial Drying	
	(inches)	*(Percent, W. B.)*	*(Percent, W. B.)*	
			Top	*Bottom*
1	22	26.3	10.7	7.1
2	22	26.5	9.7	6.6
3	22	15.1	7.7	6.8
4	34	30.7	10.6	5.4
5	27	25.4	9.9	6.0
6	18	25.2	11.4	8.8
7	32	17.1	9.3	6.8
8	18	17.1	11.1	8.2
9	44	11.5	8.6	6.2
10	37	15.5	10.7	6.9

Table 2. Percent splits and baldface kernels of Spanish-type peanuts dried in a wagon box dryer.

Test No.	Moisture Content After Artificial Drying		Percent Split Kernels*		Percent Baldfaced Kernels	
	(Percent, W. B.)					
	Top	*Bottom*	*Top*	*Bottom*	*Top*	*Bottom*
1	10.7	7.1	1.3	2.1	1.0	2.8
2	9.7	6.6	1.8	2.9	0.8	3.6
3	7.7	6.8	1.4	1.4	1.3	1.7
4	10.6	5.4	0.4	1.5	0.3	1.4
5	9.9	6.0	1.0	3.0	0.9	4.1
6	11.4	8.8	1.1	1.6	0.7	1.7
7	9.3	6.8	1.4	2.2	0.7	1.7
8	11.1	8.2	1.1	0.9	0.6	0.7
9	8.6	6.2	0.9	4.4	1.8	6.4
10	10.7	6.9	1.2	2.2	0.8	3.3

*From Official Grades

Table 3. Results of drying Spanish-type peanuts by the simulated sack drying method.

Sample No.	Depth of Bed	Moisture Content at Beginning of Artificial Drying	Moisture Content at End of Artificial Drying	
	(inches)	*(Percent)*	*Top*	*Bottom*
1	30	40.8	7.06	7.05
2	30	40.8	7.03	7.04
3	30	33.7	6.73	6.72
4	30	40.6	8.95	8.96
5	30	40.6	8.50	8.97
6	30	19.75	7.57	7.99
7	30	19.75	8.77	8.85
8	30	31.8	9.09	9.88
9	30	31.8	8.37	8.01
10	30	25.2	8.30	8.55

Figure 1. Progression of drying in conventional dryer.

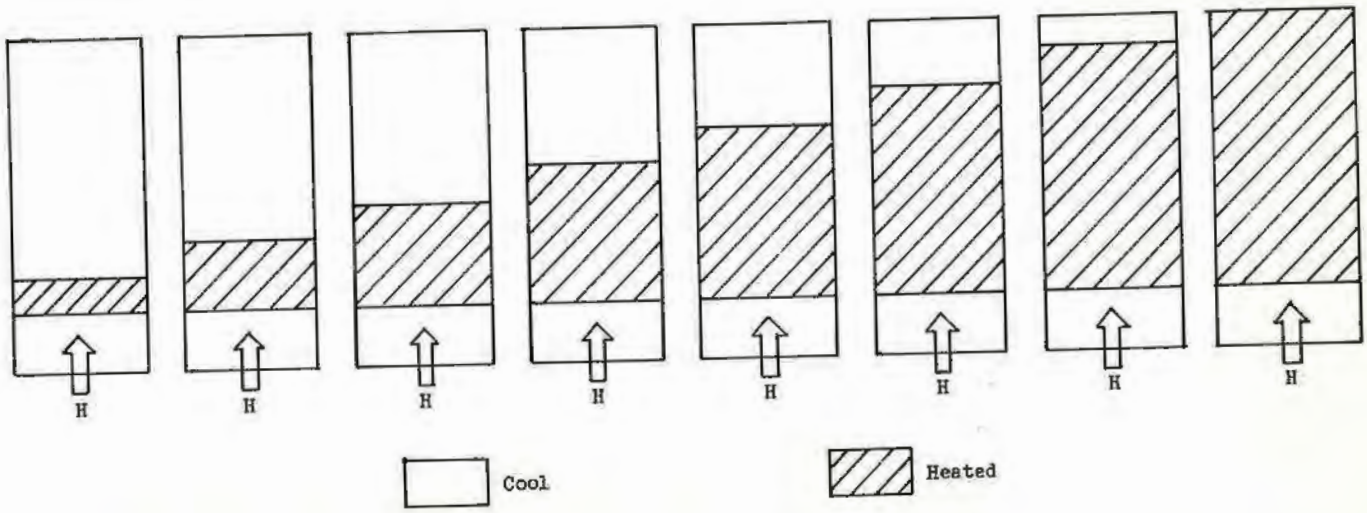


Figure 2 (Method A). Progression of drying in two-direction dryer.

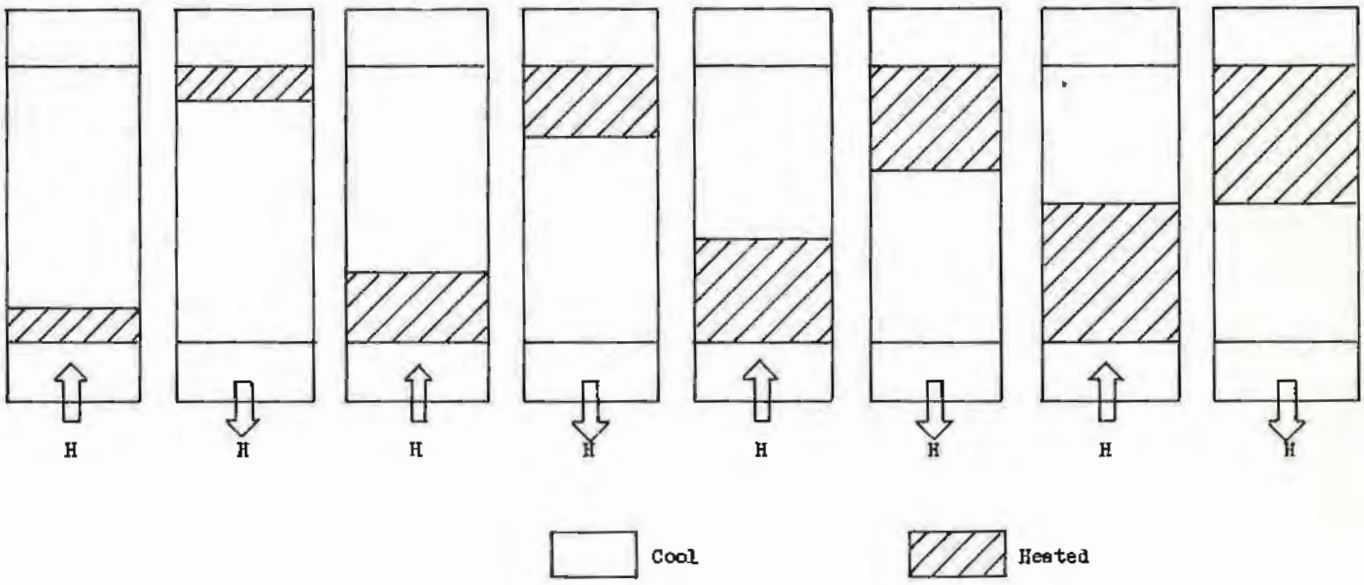


Figure 3 (Method B). Progression of drying in two-direction dryer using cooling period after each heat treatment—cooling in same direction as last heat treatment.

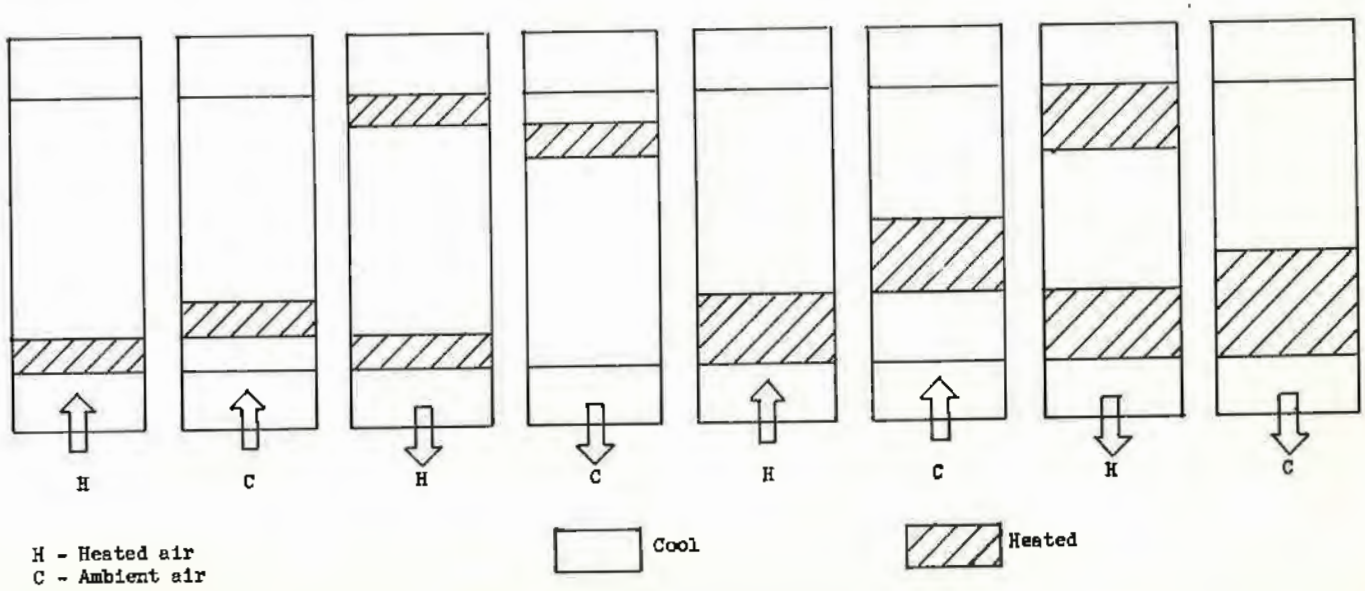
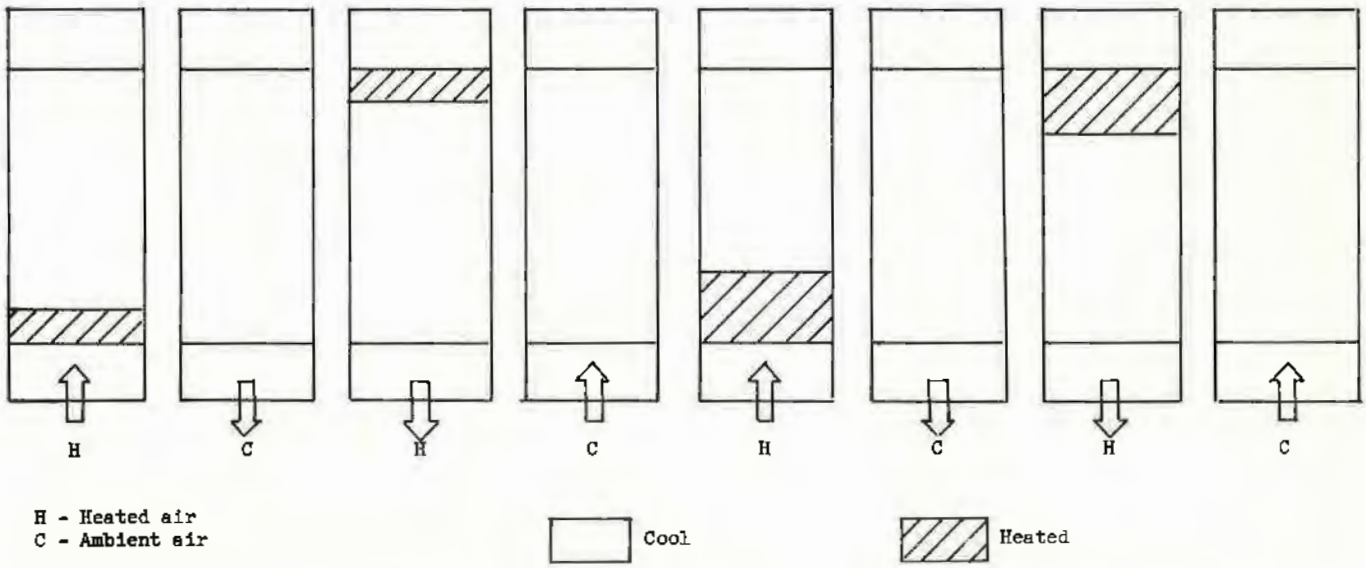


Figure 4 (Method C). Progression of drying in two-direction dryer using cooling period after each heat treatment—cooling in opposite direction from last heat treatment.



Tests during the 1964 drying season were made to compare the two methods in which cooling and tempering periods were used. Results of the 1964 tests are shown in Table 6.

In 1965 drying tests were run using an experimental, belt-type dryer designed by TFRD personnel. The dryer was so designed to allow for varying the temperature of the drying air, the airflow rate, the depth of the bed of peanuts, and the length of exposure to drying treatments. Provisions were also made to allow for periods of cooling of the peanuts as they moved down the belt.

Drying tests were run using three drying air temperatures, four periods of exposure to each drying treatment, and with three types of peanuts. Spanish- and Runner-type peanuts were dried from a moisture level of 20 to 25 percent (W.B.), and Virginia-type peanuts were dried from a 40 to 45 percent level. Artificial drying was terminated when the kernel moisture reached 10 percent. Figures 5, 6, and 7 show the percent of split kernels resulting from each treatment.

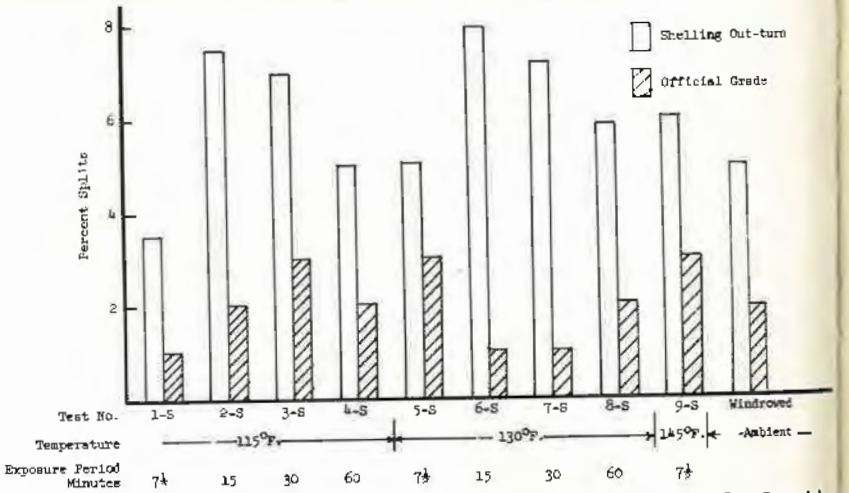


Figure 5. Effect of drying treatments on percent split kernels, Spanish peanuts.

In general the test results indicated the following: (1) Faster drying is feasible with little increase in milling damage and no apparent increase in off-flavor; (2) the length of exposure to heat is as important to maintaining market quality as is the drying air temperature itself; (3) moisture removal rates above one-half percent per hour are practical; (4) the time in the dryer may be reduced as much as 50-percent with the limited exposure method; (5) limited exposure drying reduces the moisture difference between the top and bottom of the bed of peanuts; and (6) Spanish-type peanuts are more susceptible to milling damage as a result of high temperature drying than are Runner- and Virginia-type peanuts.

Table 4. Comparison of percent splits from ambient air-dried and heated air-dried peanuts from the same lots.

Test No.	Ambient Air Dried Percent Splits	Heated Air Dried Temperature	Heated Air Dried Percent Splits[a]
1S[b]	0.18	105	3.68
2S	0.56	125	4.10
3S	0.88	130	3.04
4S	0.88	135	5.50
1R[b]	0.00	105	0.16
2R	0.38	125	0.44
3R	0.38	130	0.44
4R	0.34	135	1.88
5R	0.34	140	2.13
1V[b]	0.50	125	0.58
2V	0.50	130	0.65
3V	0.22	135	0.73
4V	0.22	140	0.85

[a]From Official Grade
[b]S - Spanish
R - Runner
V - Virginia

Table 5. Effect of drying treatments on percent split kernels for three types of peanuts - 1963.

Type of Peanut	Temperatures								
	125°			135°			145°		
	Method of Drying								
	A	B	C	A	B	C	A	B	C
Spanish	18.8	16.8	15.9	25.4	21.0	22.9	29.9	21.7	20.0
Runner	4.7	4.0	3.8	5.6	4.8	4.9	6.4	4.3	3.4
Virginia	11.2	10.4	7.7	20.1	11.0	8.3	20.5	11.9	10.5

Table 6. Effect of drying treatments on percent of split kernels for three types of peanuts - 1964.

Type of Peanuts	Temperatures					
	125°		135°		145°	
	Method of Drying					
	B	C	B	C	B	C
Spanish	7.07	7.03	13.85	5.65	11.71	13.03
Runner	0.97	1.43	2.95	4.89	6.32	7.47
Virginia	4.02	4.03	9.47	4.85	20.89	10.09

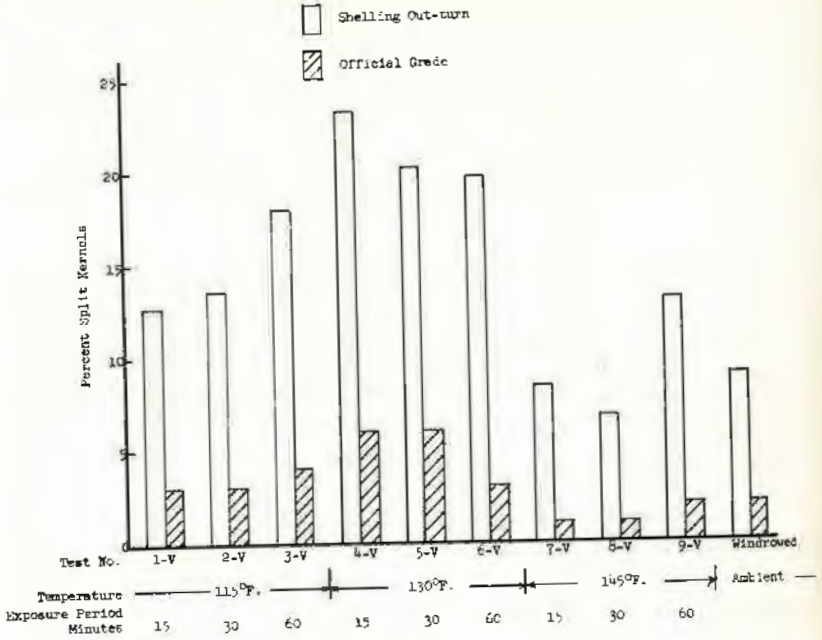


Figure 6. Effect of drying treatments on percent of split kernels, Virginia peanuts.

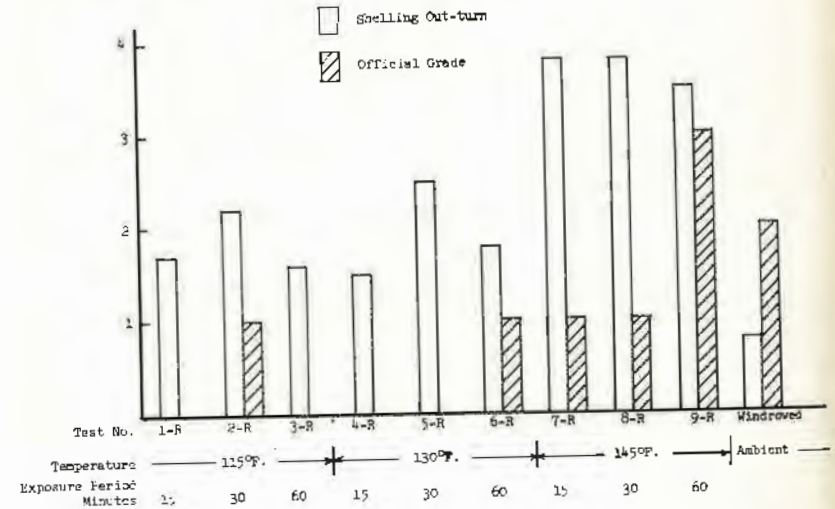


Figure 7. Effect of drying treatment on percent of split kernels, Runner peanuts.

Some Performance Characteristics of Conventional Peanut Shellers

James I. Davidson
Mechanical Engineer
Handling and Facilities Research Branch
Transportation and Facilities Research Division
ARS, USDA, Albany, Georgia

Most people are unaware of the enormous amount of machinery and equipment required to shell peanuts. Figure 1 is a schematic showing the primary operations involved in a conventional shelling plant. Equipment to perform these operations requires a considerable capital investment by the plant owner. Operating cost and efficient shelling depend largely upon the equipment, operating procedures, and techniques used by each shelling plant.

Unfortunately, there has been a lack of authentic engineering and scientific data for prescribing equipment, operating procedures, and techniques for conventional peanut shelling plants. This lack of basic data has retarded the development of needed improvements in the conventional methods and equipment, and the development of new techniques for peanut shelling.

In the past 30 years, many peanut sheller operators have developed their own equipment, operating procedures, and techniques through costly trial and error methods. Reluctance to disclose the results of these efforts has impeded the progress of the peanut shelling industry.

In 1962, the U. S. Department of Agriculture, at the urging of the peanut shelling and processing industry, set up a program in the Handling and Facilities Research Branch to develop improved work methods, techniques, and equipment for shelling peanuts. An experimental pilot-scale shelling plant set up to perform the operations shown in Figure 1 was installed at Dawson, Georgia. This plant consisted of commonly used equipment with provisions to study separately the performance of each of its components and to substitute experimental and prototype components for testing as required by results of engineering research and development work by both the U. S. Department of Agriculture and industry.

Since 1962, considerable effort has been exerted by the U. S. Department of Agriculture toward determining basic scientific data and performance characteristics of conventional-type shelling equipment, and the improvement of such equipment, methods, and operating procedures. Accomplishments have been realized in the following areas:

1. Evaluation of some operating characteristics of four different commercial shellers including the effect of sheller speed on the whole kernel out-turn of Runner-, Spanish-, and Virginia type peanuts.

2. An indication of the effect of grate size on the whole kernel out-turn of Runner-type peanuts.
3. A correlation of official grade data with actual shelling results.
4. The pod and kernal size distribution of varieties of Runner-, Spanish-, and Virginia-type peanuts for presizing work and correlation of this work with actual shelling results.
5. The effect of different drying methods on the shelling quality of Runner-, Spanish-, and Virginia-type peanuts.
6. An indication of the effect of the quantity of sticks in the farmers stock peanuts on the whole kernel out-turn of Spanish-type peanuts.

Conventional Sheller Characteristics

From Figure 1, it can be seen that there are normally four stages of shelling in most shelling plants. Normally, the first stage sheller shells from 60 to 70 percent of the total amount of peanuts and is considered the primary controller of shelling plant performance. A good shelling plant performance is normally characterized by maximum whole kernel out-turn and a high shelling efficiency. To evaluate the characteristics of the first stage of shelling and to determine the optimum sheller speed, a series of shelling tests was conducted of four types of commercial first-stage shellers for the three common types of peanuts (Runner, Spanish, and Virginia). These four commercial shellers were known by the following trade names (1) Appomattox, (2) Hendrick, (3) Medley, and (4) Pearman. The design characteristics of each sheller are shown in Figure 2.

Prior to a series of shelling tests, the entire shelling plant was set up for optimum shelling, and the speed of the first-stage sheller was set at increments of 20 RPM from 165 to 325 RPM. The out-turn of split kernels from the shelling plant and other pertinent operating data were recorded for each of the nine RPM settings. Curves were plotted to determine the shelling characteristics of each sheller. Duplication of data under different conditions and the data analysis confirmed the reliability of the data and the significance of the effects. Composite curves for each of the four shellers are shown in Figures 3 through 6. A summary of data is presented in Table 1. Unfortunately all peanuts, except the Runner type, were of exceptional shelling quality, and the effects of sheller speed on kernel damage were not as obvious as the effect would have been for peanuts of normal quality. Note the more obvious effect of sheller speed on sheller characteristics for the Runner-type peanuts. The data established a definite effect of sheller speed on kernel damage for all four makes of shellers. Generally, the percent of split kernels increased with an increase in speed from 165 to 325 RPM. Optimum points were characteristic of many conditions, while a linear increase in percent of split kernels with speed was well established for other conditions. Inflections or optimum points were characteristic for

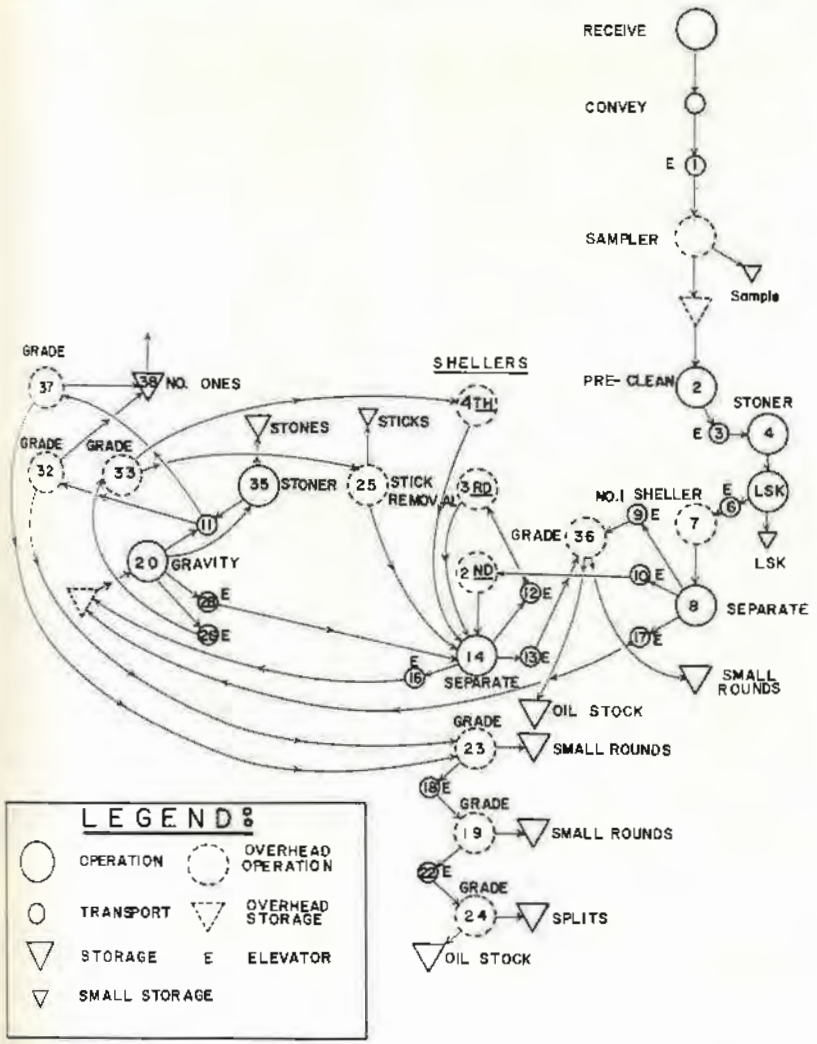
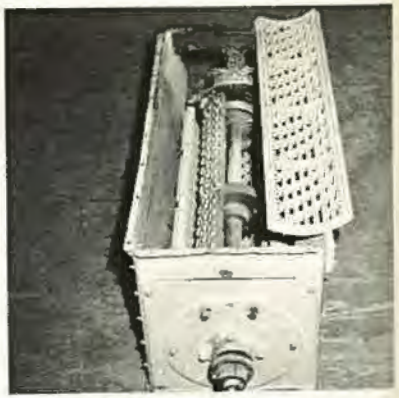


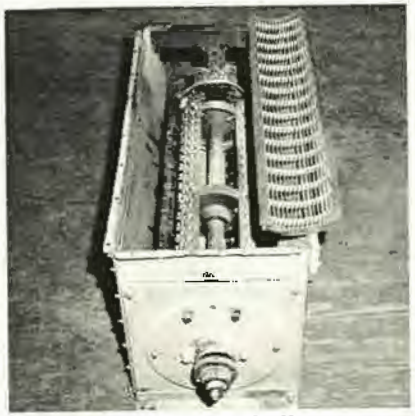
Figure 1. Process chart of pilot shelling plant.

all shelling of the Runner-type peanuts. The Hendrick and Medley sheller exhibited similar characteristic operating curves and optimum sheller speeds whether shelling Runner- or Spanish-type peanuts. Except for the Pearman sheller, sufficient data were not obtained to establish characteristic curves for the Virginia-type peanuts. The characteristics of the operating curves for the Appomattox and Pearman shellers were dependent upon the type of peanut shelled. It was quite evident that a change in the variety of Spanish-type peanuts shelled did not significantly affect the characteristics of the operating curves, but merely shifted the curve up or down the ordinate (percent of splits).

Appomattox Sheller



Medley Sheller



Hendrick Sheller

Pearman Sheller

Figure 2. Photographs showing the sheller bar and grate designs for the four types of commercial shellers—Appomattox, Medley, Hendrick, and Pearman.

Some shellers were significantly better than others in terms of minimum kernal damage; however, the better sheller in this respect often displayed severe shelling rate problems at the optimum speeds. Shelling rate data for all four types of first-stage shellers will be recorded for this year's tests in case a compromise between kernel damage and increased shelling rate is required for certain shellers.

Representative samples from underneath each first-stage sheller were taken during the shelling test and analyzed to determine the shelling efficiency, size of peanuts shelled, and kernel damage caused by each sheller. Those data and sheller speed test data have been compared to relate the differences in operating characteristics of the shellers to the differences in sheller design. These comparisons get rather complicated and detailed and will not be presented here, except to indicate the

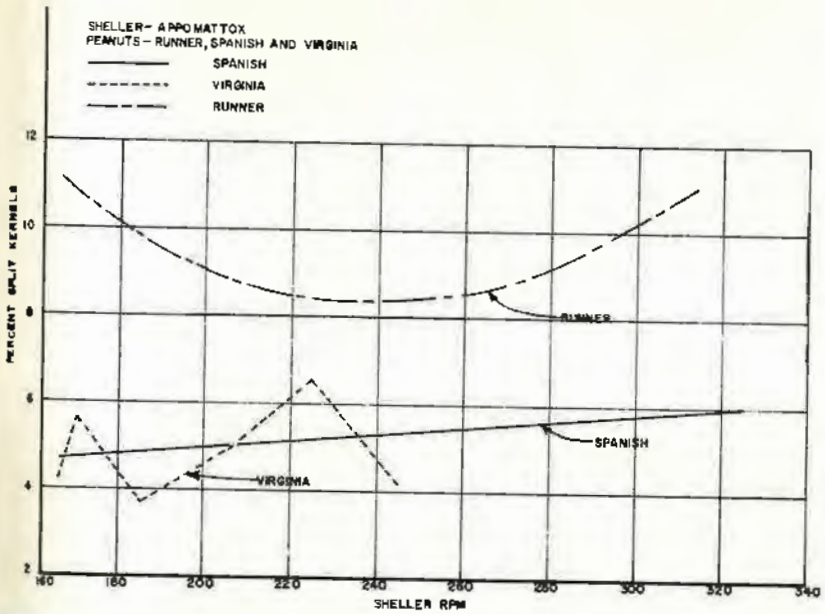


Figure 3. Percent split kernels versus sheller RPM for certain grades of Runner-, Spanish-, and Virginia-type peanuts when shelled by Appomattox sheller.

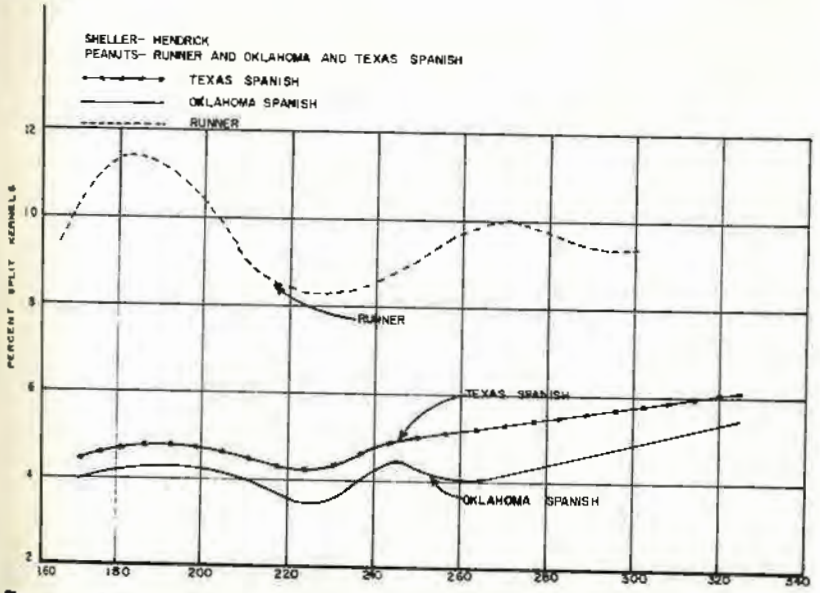


Figure 4. Percent split kernels versus sheller RPM for certain grades of Runner- and Spanish-type peanuts when shelled by Hendrick sheller.

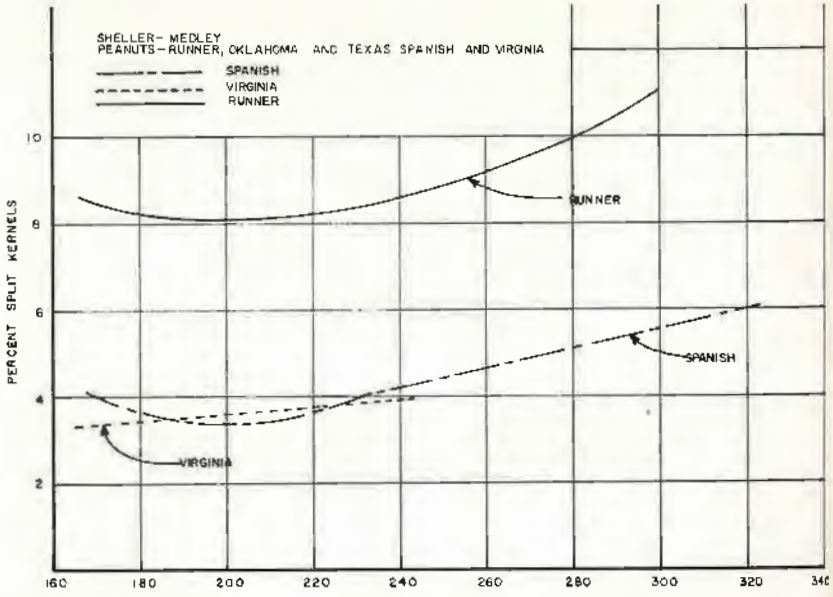


Figure 5. Percent split kernels versus sheller RPM for certain grades of Runner-, Spanish-, and Virginia-type peanuts when shelled by Medley sheller.

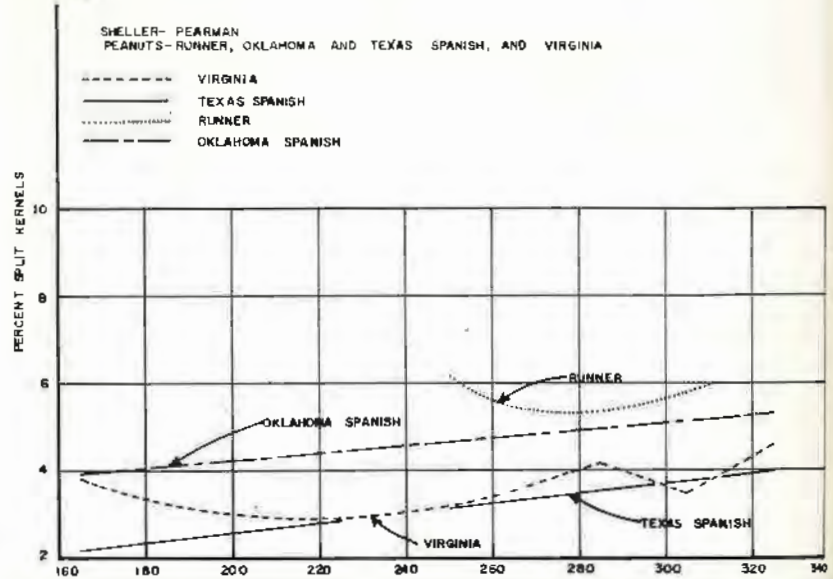


Figure 6. Percent split kernels versus sheller RPM for certain grades of Runner-, Spanish-, and Virginia-type peanuts when shelled by Pearman sheller.

comparisons, the potential of such an analysis, and some general conclusions.

Note from Figure 2 that the Medley and Hendrick shellers were identical except for the sheller grates. Also, note that the Appomattox and Hendrick shellers have similar grates but different sheller bars. The Pearman sheller has the simplest grate design (basket type) and a different sheller bar design. The shelling efficiency of the Medley and Hendrick shellers was approximately 60 percent (Spanish-type) while the shelling efficiency of the Appomattox and Pearman shellers was about 70 percent. Analysis of the data when making these comparisons has indicated a relatively marked importance of sheller bar design, a definite difference in sheller action for the four types of shellers, and a difference in shelling rates for the four types of shellers.

Other Phases of Research Work on Improving Peanut Shelling

The above discussion has been limited to only a small part of the research work conducted to improve the techniques, procedures, and equipment for shelling peanuts. Considerable research work has also been performed recently by the U. S. Department of Agriculture in other areas of this field as follows:

1. An investigation of sheller grate size to determine the effect of grate size on the shelling characteristics of conventional shellers.
2. Sizing and presizing investigations of unshelled and shelled peanuts from farmers stock samples and from samples from each stage of shelling to provide basic sizing data for: (a) Correlation of pod size to kernel size and correlation of pod and kernel size to actual shelling results, (b) the selection of size groups for presizing, (c) a better selection of grate sizes for more efficient shelling, and (d) better insight into shelling actions.
3. Correlation of official grade data with actual shelling results to provide a basis for better adjustments to the official grade predictions where such adjustments are deemed necessary.
4. Shelling peanuts which have been artificially dried to determine the effects of the different drying methods on the shelling quality of peanuts.
5. Improvement in methods, equipment, and techniques for cleaning farmers stock peanuts and to determine the effect of sticks and foreign material on shelling results.

Future Work

Future work includes: (1) Completion of the sheller speed tests; (2) continued grate size investigation; (3) investigation of new sheller bar designs for Hendrick, Medley, and Appomattox shellers; (4) evaluation of shelling rates for the four makes of shellers; (5) continued

Table 1. Effect of sheller speed on percent of split kernels obtained from farmers stock peanuts for speed range of 165 to 325 RPM.

Type Peanut	Type Sheller	Optimum Speed For Minimum Percent Splits	Percent Splits at Optimum Speed = X	Average Percent Splits for Speed Range	Average Percent Splits Predicted by Official Grade = Y	Ratio of X to Y	Regression	Regression Equation Percent Splits
Runner	Appomattox	240	8.4	9.7	3.0	2.80	Curvilinear	0.000498(RPM)² -0.240 RPM + 37.30
	Hendrick	225	8.3	9.6	3.5	2.37	Curvilinear	
	Medley	200	8.2	9.1	3.0	2.73	Curvilinear	0.000286(RPM)² -0.114 RPM + 19.58
	Pearman*	280*	5.3*	5.7	2.6	2.04	Curvilinear	
Spanish	Appomattox Okla. Spanish	165	4.67	5.3	3.9	1.20	Linear	0.00865 RPM + 3.241
	Hendrick Okla. Spanish	225	3.4	4.3	4.6	0.74	Curvilinear	
	Hendrick Texas Spanish	225	4.2	5.0	4.1	1.02	Curvilinear	
	Medley Okla. Spanish	203	3.4	4.3	3.7	0.64	Curvilinear 165 to 285 RPM	0.00074(RPM)² -0.30 RPM + 33.8
	Medley Texas Spanish			4.8	5.3		Linear 235 to 325 RPM	0.224 RPM − 1.17
	Pearman Okla. Spanish	165	3.9	4.7	4.6	0.85	Linear	0.0091 RPM + 2.45
	Pearman Texas Spanish	165	2.2	3.1	4.7	0.47	Linear	0.012 RPM + 0.195
Virginia	Appomattox*	185*	3.6	4.8	3.4	1.06	*	*
	Medley*	165*	3.3	3.7	3.1	1.06	Linear	0.00875 RPM + 1.91
	Pearman	220	2.9	3.5	3.6	0.81	Curvilinear	0.000287(RPM)² -0.126 RPM + 16.85
Runner	Medley, size 28 Basket	165	9.0	9.4	3.1	2.90		
	Pearman, size* 28 Basket	165	5.6	7.2	3.2	1.75		0.534 RPM − 0.0009(RPM)² − 72.2

correlation of official grade data with shelling results; (6) continuation of sizing work with emphasis on correlation of sizing with actual shelling results, and development of a full-scale presizer; (7) continuation of tests to determine the effect of new drying methods on the shelling quality of peanuts; and (8) initiation of a program to design and develop new techniques for shelling peanuts.

Relationship of Soil Treatment and Method of Drying to Quality of Peanuts and Peanut Butter

Malcolm C. Thomas and Carl M. Lyman
Biochemistry and Nutrition Department
Texas A & M University
College Station, Texas

Four plots, one half acre each, were planted with a Spanish type peanut "Starr" on May 27. Two of the plots were irrigated on July 21, and August 7, 2.5 inches of water each time. Two plots, one irrigated and one not irrigated, were treated at planting time 10 pounds per acre of pentachloronitrobenzene by spreading the powder in a 12-inch band over the planted row and mixing it with the soil using rotary hoes. The rainfall for the growing season was 0.49 inch in June, 1.59 inches in July, 3.60 inches in August, 6.10 inches in September, and 2.07 inches in October.

The peanuts were dried by three different methods; in the field, in burlap bags suspended from the ceiling, and heat dried at 120°F. with forced air.

Samples of peanuts from each group were roasted at three different temperatures and evaluated by a taste panel as fresh roasted peanuts and as peanut butter. Other samples were fried and evaluated by the taste panel.

PROCEDURES

Methods of Drying

Heat drying

Freshly harvested peanuts were put in drying bins to a depth of 36 inches. The bins were equipped with screen bottoms to allow hot air (120°F) to be forced through the peanuts. The peanuts were allowed to stay in the dryers until the moisture was reduced to approximately 6 percent.

Bag drying

Freshly harvested peanuts were put in burlap bags, about 25 pounds per bag of green peanuts. The bags were suspended from the ceiling by

wire, spaced well apart. For the first week the peanuts were stirred each day and less often as they dried. It took two months for the moisture level to drop below 10 percent.

Field drying

The peanuts were dug and windrowed by a side delivery rake and allowed to dry in the windrows for five weeks. They were turned once by the side delivery rake. The moisture level was about 10 percent at the time they were brought from the field.

Roasting

Equipment

An oven equipped with a timer, thermostat, rotisserie basket (5½ inches in diameter and 15 inches long), and a thermometer to register the temperature inside the basket.

Temperature for roasting

Three different temperatures and lengths of time were used in roasting to select the most desirable degree of roasting for the different samples. The oven and rotisserie basket were brought to 150°F before placing the 200 gram sample of peanuts in the basket.

Light roasted samples: The basket temperature was brought to 300°F and held for 5 minutes. The peanuts were placed in a ventilated pan to cool in front of a small fan.

Medium roasted samples: The procedure used for the light roasted samples was followed except a basket temperature of 325°F was reached and held for 5 minutes.

Well roasted samples: The basket temperature was brought to 350°F and the peanuts were removed immediately and cooled in front of a small fan.

Sample Preparation after Roasting

The peanuts were brought to room temperature and put through a "Nut Splitter and Blancher" (manufactured by the Bauer Brothers Company, Springfield, Ohio) to remove the husk, split the kernel, and remove most of the hearts from the peanuts.

Organoleptic Tests

A panel of 12 members were trained to taste dry roasted peanuts without salt and to recognize difference in palatability. Three or four samples were served to each panel member which he rated according to his preference. A score of three was given for each first choice; a score

of two for second choice; a score of one for third choice; and zero for a fourth choice. All tests were conducted between 3:30 and 4:00 p.m.

Fried Peanuts

Equipment

An electric skillet with an automatic heat control, manufactured by Sunbeam, was used to fry the peanuts. A screen wire basket held the peanuts in the oil off the bottom of the skillet.

Conditions for preparation of the fried peanuts

The samples were fried at three different temperatures in order to determine the best conditions for the preparation of high quality products. Two hundred gram samples were fried in two quarts of peanut oil manufactured by Planter, Suffolk, Va. The oil was brought to the desired temperature before adding the peanuts.

Lightly fried samples: 320°F for 20 minutes.

Medium fried samples: 340°F for 20 minutes.

Well fried samples: 360°F for 20 minutes.

All fried samples were drained on paper towels while hot to remove as much of the oil as possible. After cooling, they were put through the blancher-splitter as described in the roasting procedure.

Sample preparation after frying

The sample preparation after frying is the same as that described for the roasted peanuts.

Peanut Butter

Equipment

1. A Quaker City Mill, Model 4E, direct motor driven, 4 inch diameter grinding plates, speed about 90 revolutions per minute, from E. H. Sargent Co.
2. Sample mixer (for blending the additives to the peanut butter). Aloe Mixer with variable speed, rotating bowl.

Procedure for making peanut butter

After the peanuts are roasted, blanched and hand picked, they were ground in a peanut butter mill. The sample is weighed and the amount of each ingredient to be added is determiued. The ingredients and amounts of each are given below:

Hydrogenated vegetable oil	3.0%
Refined peanut oil	1.5%
Glycerol	0.5%
Powdered salt	1.0%
Powdered dextrose	1.0%
Ground peanuts	93.0%

The salt and the dextrose are ground three times each to obtain a fine powder. The peanut oil, glycerol, and melted hydrogenated vegetable oil are mixed and added to the ground peanuts; the salt and dextrose are mixed in last.

Results and Discussion

A. Relationship of Methods of Roasting and Frying to Quality

The results of the organoleptic tests showed that mature, medium roasted peanuts were of better quality than either light roasted or well roasted peanuts (Table 1). The light roasted peanuts were significantly lower in quality (statistically) as indicated by these tests. Well roasted peanuts were rated lower than medium roasted kernels but the differenees were not significant.

The results of organoleptic tests on peanut butter made from the roasted peanuts were essentially the same as those obtained with fresh roasted peanuts with small variations in the tests' values.

The results of the organoleptic tests for fried peauuts showed that the light fried peanuts were significantly lower in quality than the medium or well fried peanuts. They were lighter in color and lacked flavor. The organoleptic values for the medium fried and the well fried peanuts were essentially equal. When the temperature was increased by 10 degrees in the preparation of the well fried peanuts they were discolored considerably.

B. Relationship of Maturity to Quality

Organoleptic tests were conducted on three maturity classifications of peanuts, (mature, immature, undeveloped) processed by frying, or dry roasting, or as peanut butter. In each of the tests the mature peanuts were significantly superior in quality to the other two classifications, as shown in Table 2. The undeveloped peanuts were rated as inferior and of poor quality. The mature fried peanuts were rated as the best quality for the method of processing. The immature peanuts were significantly of better quality than uudeveloped peanuts.

C. Relationship of Irrigation to Quality

The organoleptic tests' values showed that peanuts grown under irrigation were superior in their eating quality to the peanuts that were not irrigated. Orgauoleptic tests were conducted on peanuts that were dry roasted, fried in peanut oil, and roasted and made into peanut butter (See Table 3). Each of these tests showed that the irrigated peanuts were preferred by the organoleptic panel which indicated a superior quality product. The organoleptic value for the irrigated peanuts was 50 points higher, a statistically significant difference from the control lot. A perfect score would be 300.

Table 1. Organoleptic evaluations for method of cooking.

Description of product	Cooking conditions		
	Light	Medium	Well
Fresh Roasted Nuts	1.47	2.42	2.14
Fresh Fried Nuts	1.32	2.32	2.34
Peanut Butter	1.53	2.32	2.15
Average	1.44	2.36	2.20

Table 2. Organoleptic evaluations for maturity as indicated by size and development of kernel.

Description of product	Mature (size 17)	Immature (size 15)	Undeveloped (size 12)
Fresh Roasted Nuts	2.50	2.15	1.35
Fresh Fried Nuts	2.67	2.04	1.29
Peanut Butter	2.56	2.18	1.26
Average	2.57	2.11	1.36

Table 3. Organoleptic evaluations for soil treatments.

Description of product	Control	Irrigated	Fungicide	Irrigated Fungicide
Fresh Roasted Nuts	1.39	1.82	1.24	1.55
Fresh Fried Nuts	1.29	1.89	1.17	1.65
Peanut Butter	1.33	1.76	1.10	1.81
Average	1.33	1.83	1.17	1.67

Table 4. Organoleptic evaluations method of drying.

Description of product	Heat dried	Bag dried	Field dried
Fresh Roasted Nuts	1.55	2.30	2.15
Fresh Fried Nuts	1.71	2.29	2.00
Refrigerated One Week	1.85	2.14	2.01
Peanut Butter	1.40	2.43	2.17
Average	1.63	2.29	2.08

D. Relationship of Soil Fungicide to Quality

The organoleptic tests' values for peanuts that were produced in plots treated with the fungicide, pentachloronitrobenzene, were not significantly different from the organoleptic values of the non-treated plots. However, the tests' values for peanuts from fungicide treated plots were higher than peanuts from control plots by 12 and 14 points when fried or dry roasted. Peanut butter organoleptic values were 16 points higher for the PCNB treated peanuts than for the control peanuts. A summary of organoleptic tests on the relationship of soil treatments to quality is given in Table 3.

From the above data, the conclusion may be drawn that irrigation did significantly improve the quality of dry roasted, fried peanuts and peanut butter. Soil treated with pentachloronitrobenzene did not significantly change the quality of the peanuts or peanut products.

E. Relationship of Method of Drying to Quality

Samples of peanuts from three different drying methods were fried, dry roasted, made into peannt butter, and evaluated hy a trained organoleptic panel. The peanuts that were allowed to dry at room temperature in burlap bags were of superior quality to the heat dried peanuts. The field dried peanuts were also of better quality than the heat dried peanuts; however, they were rated by organoleptic tests slightly below the bag dried peanuts. These values are given in Table 4. Statistical analysis showed that the difference between the heat dried peanuts and the other two methods were significant. The difference between the field dried peanuts and the bag dried peanuts was not significant.

Roasted peanuts stored in the refrigerator for a week in unsealed jars lost flavor and were rated as poor quality peanuts by the panel. The three methods of drying were rated about equal after a week in the refrigerator.

The differences in the methods of drying were more evident in the peanut butter tests. There was a significant difference between each of the drying methods. The highest quality peanut butter was made from peanuts grown on irrigated, PCNB treated soil and dried in burlap hags.

Summary

Peanuts from four soil treatments dried by three methods were compared in organoleptic tests. Organoleptic tests indicated that peanuts grown nnder irrigated conditions were of hetter quality than those grown without irrigation. Treating the soil at time of planting did not significantly affect the quality of the peanuts. Elevated temperature to speed the drying process reduced the quality of the peanuts and peanut products. Organoleptic tests showed that mature peanuts are of superior quality to immature and undeveloped peanuts.

The Effect of Weed Control Upon Production of Spanish Peanuts

T. E. Boswell
Plant Disease Experiment Station
Yoakum, Texas

The effect of weeds upon peanut yields has often been estimated in trying to place a dollar value on the annual loss in peanut production. In most instances this is based upon the experience and observations of the estimator with little or no supporting data from research tests. Also, the effect and interrelationship of weed control with other production practices and factors which can cause losses complicates this business of estimating the loss in a crop.

The peanut grower has often asked himself and others, "How much can I afford to spend for weed control?, or "Will it be profitable to grow peanuts in a severely weed infested field?, or "How much reduction in yield can I expect from a severe weed problem?," or "Will it be profitable to have a certain field hand hoed?" The answer to these and other questions was usually "I do not know", or if one was given it would include many reservations.

Realizing some of the problems and shortcomings in trying to estimate losses in peanut production, tests were conducted which we think give us an indication of the potential losses from weeds which can occur in peanuts. An area with a natural infestation of weeds was selected. Three main comparisons were made in these studies. They were: (1) no weed problem throughout the season; (2) an early season weed problem; and (3) a full season weed problem. The weed free conditions throughout the season were maintained by the use of DCPA at 6 lbs/A active (broadcast basis) in 1963 and a mixture of trifluralin and diphenamid at 0.5 + 2 lbs/A active in 1964. The plots with an early season weed problem were hand weeded to maintain weed free conditions throughout the rest of the season. The plots with a full season weed problem received no hand weeding but only standard cultivation.

The peanuts were planted in a slightly raised flat top bed in order to obtain the maximum benefit from the herbicide treatments and also to minimize the damage from the southern blight disease. In the 1964 test the herbicides were applied and incorporated as preplant treatments. In 1964 diphenamid at 2 lbs/A and vernolate at 2 lbs and 3 lbs/A were included to determine what effect various degrees of weed control would have upon peanut yields.

The tests received supplemental furrow irrigation as needed. The main weed problem consisted of *Panicum texanum* and *Digitaria songuinalis* with some *Mollugo verticillata* and *Portulaca sp.*

Results

Excellent weed control was obtained in 1963 with DCPA and in 1964 with trifluralin and diphenamid giving essentially weed free conditions throughout the season. In Table 1 are the yield data in pounds per acre and value per acre from these plots and the untreated plots. There was a 44-percent (924 lbs) loss in yield in 1963 and a 58-percent (1623 lbs) loss in 1964. This represents a loss in value per acre of $118.43 and $177.56 for the two years, respectfully. A loss of 24-percent (498 lbs) and 26-percent (741 lbs) occurred in plots with an early season weed problem (hand weeded checks) as compared with the hand weeded herbicide treated plots in 1963 and 1964, respectfully. The herbicide treated plots (not weeded) produced 7 percent (144 lbs) and 4 percent (109 lbs) less per acre than did the same treatments which were hand weeded.

In Table 2 are given the weed counts, yield data in pounds per acre and value per acre for the 1964 test. As previously stated, the mixture of trifluralin and diphenamid gave the best control in the test which lasted throughout the season. Diphenamid at 2 lbs/A and vernolate at 2 and 3 lbs/A gave less satisfactory control although the weeds were stunted and did not develop as rapidly as in the untreated check plots. This was evident when the plots were hand weeded with the weed seedlings being easier to remove from the treated plots than from the check plots. The higher yields from these plots also indicate that the weeds were not as competitive in these plots as in the untreated ones. The peanut plants in the hand-weeded check plots were stunted and this was apparent throughout much of the season when compared to the weed free herbicide treated plots.

In the 1964 test the unweeded diphenamid at 2 lbs/A produced 45 per cent (1263 lbs) less than the weed-free plots but the yield from the hand-weeded diphenamid plots was only 9 percent (251 lbs) less. Vernolate at 2 lbs/A produced 38 percent (1045 lbs) less than the weed free treatment, whereas the same treatment which was hand-weeded had only an 8 percent (218 lbs) loss in yield. The 3 lb rate of vernolate produced 52 percent (1437 lbs) less, and the hand-weeded vernolate plots were 16 percent less than the weed-free plots.

These data indicate that a reduction in yield of 44 to 48 percent can occur in peanuts with a severe weed problem. Also, they show that a significant reduction in yield of 24 to 26 percent can occur in hand-weeded plots which had an early season weed problem. This loss is attributed to the combined effects of the early weed problem and the damage from the hand weeding operation.

These data suggest that weed control investigators working with peanuts, and possibly other crops, should be very careful in interpreting data from tests in which yields are compared between weed free treatments and check plots which have had an early season weed problem.

These increased yields over the check plots could very easily be erroneously interpreted as due to the herbicide having fungicidal or other activity instead of the effect of the early weed problem in the untreated plots. We would like to caution weed control investigators to consider these findings when evaluating their results.

Table 1. Weed control tests — Yoakum, Texas.

Treatment	1963 Nuts Lbs/A	1963 Value/ Acre	1964 Nuts Lbs/A	1964 Value/ Acre
Check	1155	$131.08	1154	$131.28
Check (Hand weeded)	1581	193.78	2036	216.77
Herbicide	1935	232.58	2668	282.55
Herbicide (Hand weeded)	2079	249.51	2777	308.84

Herbicide in 1963 - DCPA @ 6 lbs/A active (broadcast basis)
Herbicide in 1964 - Trifluralin + diphenamid @ 0.5 + 2 lbs/A (broadcast basis)

Table 2. Preplant incorporated test — Yoakum, Texas — 1964.

Treatment	Lbs/A	Weed Counts	Not Hand Weeded Nuts Lbs/A	Not Hand Weeded Value Acre	Hand Weeded Nuts Lbs/A	Hand Weeded Value/ Acre
Check	0.0	655	1154	$131.28	2036	$216.77
Diphenamid	2.0	285	1514	160.50	2526	273.89
Vernolate	2.0	575	1623	183.33	2559	235.22
Vernolate	3.0	535	1231	139.84	2330	247.81
Trifluralin+ diphenamid	0.5+ 2.0	4	2668	282.55	2777	308.84

Some Parameters in Fungicidal Control of Seedling Collar Rot[1]

Billy R. Clay, Raymond Arnold, and J. Q. Lynd
Graduate Assistant, Instructor, and Professor of Agronomy
Oklahoma Agricultural Experiment Station
Stillwater, Oklahoma

Abstract

Effectiveness of four fungicides; Difolatan, Captan, Ceresan M, and Arasan were determined using four levels of application with *Arachis hypogaea*, var. Argentine, for seedling collar rot inhibition. A *Typic*

[1]Approved for publication as Journal paper 1369, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma.

Quarzipsamment (Eufaula) soil was used with differential autoclaved and pathogen contaminated treatments. Pathogen inoculants included *Fusarium*, *Rhizoctonia*, *Penicillium*, and *Aspergillus niger*. Interactions in soil treatments, disease control and seed germination inhibition were significant. Dry weights of plant material were generally greater from autoclaved than inoculated treatments. Higher rates of fungicides appeared no more effective than lower rates in pathogen control. However, the higher Ceresan M levels did inhibit germination.

The so-called collar rot of peanut was first noted in this country in 1961 in Georgia (4). Since then it has spread to the peanut producing areas of the Midwest causing serious losses to growers in the form of seedling stand deterioration (1, 2). The disease is reported to cause seedling injury at both pre- and post-emergence stages and is either seed or soil borne (1,2,3,4,5,6). Early investigations revealed that a number of organisms may produce the pathogenic effects; those suggested were *Aspergillus* sp., *Rhizoctonia* sp., and *Fusarium* sp. (3). Sturgen (7) suggested that *Rhizoctonia* was a major pathogen of the group, while others (1,2,3,4,5) indicated *Aspergillus* more prominent. Ashworth (1) and Jackson (4) in greenhouse studies with *Aspergillus niger* obtained up to 90 percent kill of peanut seedlings. Less severe kill was reported in other studies (1, 6).

The disease is characterized by rotting of the seeds before emergence or by wilting of the emerged seedlings, accompanied by rotting of the hypocotyl region. Nema et al. (6) reported that uninjured seeds were infected by fungal mycelium while seeds with broken testa could be infected by conidia.

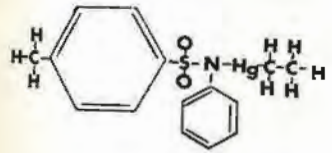
Several fungicides have been tested for control of this disease. Reduced seedling kill has been reported in all cases (1,2,3,4,6). Gibson (3), however, reported that certain isolates of *Aspergillus* are mercury tolerant and that the partial soil sterilization produced by organomercurial materials operates to the advantage of the fungus. Morwood (5) reported that the mercuric fungicides were effective in pre-emergence control while other materials such as Thiram or Captan provided control at hoth pre- and post-emergence stages. Ashworth (1, 2) produced similar results and contended that double treatments of these fungicides were no more effective in controlling the disease than single treatments. However, seedling damage due to the fungicide occurred with high rates of the organomercurial compounds (4).

An important problem for stand establishment is the control of *Aspergillus niger* and other pathogens. The epidemiology of this disease has been established, but there is need for an evaluation assay for fungicide types and levels to provide good control with minimum germination injury.

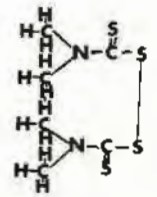
The objective of this study was to compare four fungicides at four levels of application as to control for induced seedling collar rot and to evaluate the effects of these chemicals on germination inhibition and seedling injury.

Materials and Methods

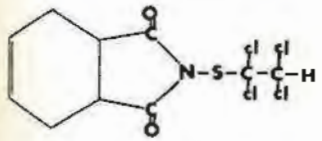
Four fungicides, each at four levels, were used. One-pound lots of Argentine variety peanut seeds were treated with 7.7 percent Ceresan M, 50W Arasan, 50W Captan, and 80W Difolatan. The chemical configurations of these fungicides are shown in Figure 1. The low-level treatments were at the recommended rates of 1.66, 3.0, 2.0, and 2.0 ounces per 100 pounds, respectively. The high-level treatments were 2 and 4 times the recommended rates.



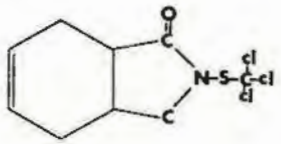
CERESAN M



ARASAN



DIFOLATAN



CAPTAN

Figure 1. Structural formulas of the four fungicide materials used in this study.

Both pot and soil-less plastic bag cultures were used with three replicate cultures for each treatment in all experiments. Ten seeds were planted in pots containing 400 grams of Eufaula fine sand. Half of the pots were steam autoclaved for 24 hours and the remainder were reinforced with a mycelia-spore mixture of *Aspergillus niger*, *Penicillum funiculosum*, *Fusarium* sp., and *Rhizoctonia* sp. Check pots with no fungicidal treatments were used in both the autoclaved and pathogen inoculated culture series. The plastic bag cultures were treated in a similar manner using tap water only as the growth medium. Five seeds were planted in each bag culture and only *Aspergillus niger* was used as the inoculant.

Dry weight of total plant material was used as a measure of seedling injury due to either the pathogen, the fungicide, or both.

The soil used was 89 percent sand, 4.6 percent silt, and 6 percent clay. The pH was 5.7 and organic matter and total nitrogen were 0.47 and 0.04 percent, respectively. Cation exchange capacity was 2.7 m.e./100 g. with exchangeable calcium, magnesium, and potassium at 1.1, 0.86, and 0.26 m.e./100 g., respectively.

Results and Discussion

Total plant material, tops and roots, produced with three replicate cultures for each treatment, are shown in Figure 2 for Ceresan M. The upper series were from the autoclaved soil and the lower series from the pathogen inoculated soil. Figures on each box are percent growth obtained as compared to the check nontreated plants grown in the autoclaved soil (100%). Nontreated check plants grown in the pathogen inoculated soil yielded only 88 percent of those nontreated plants grown in autoclaved soil. Improved growth was obtained in the pathogen inoculated series when Ceresan M was used at the recommended rate of 1.6 oz./cwt. of peanut seed. Germination inhibition was extreme at the higher levels of Ceresan M application.

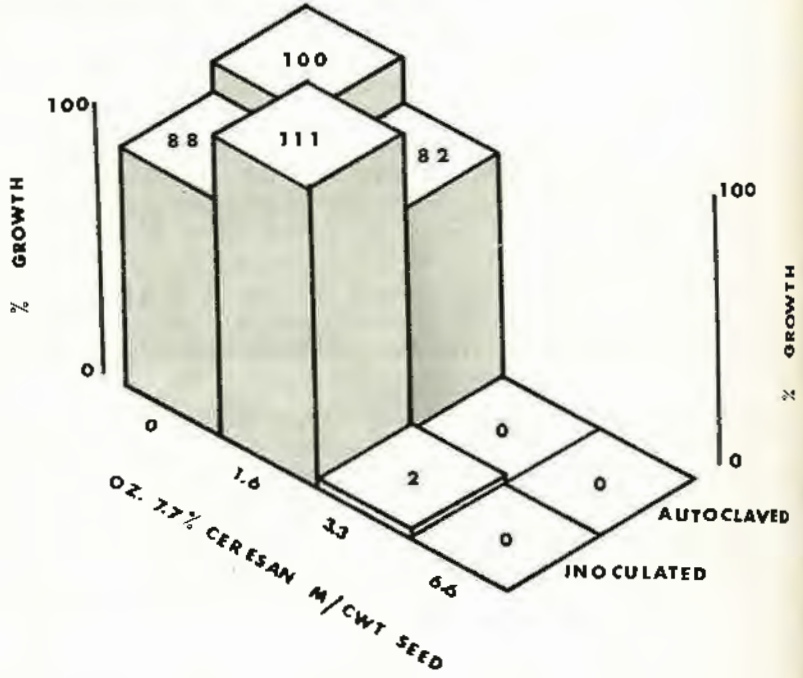


Figure 2.

Arasan likewise increased growth of plants in the pathogen inoculated series when used at the recommended level of 3 oz./cwt. of seed, see Figure 3. A higher fungicide level was apparently not favorable for vigorous seedling growth in these studies.

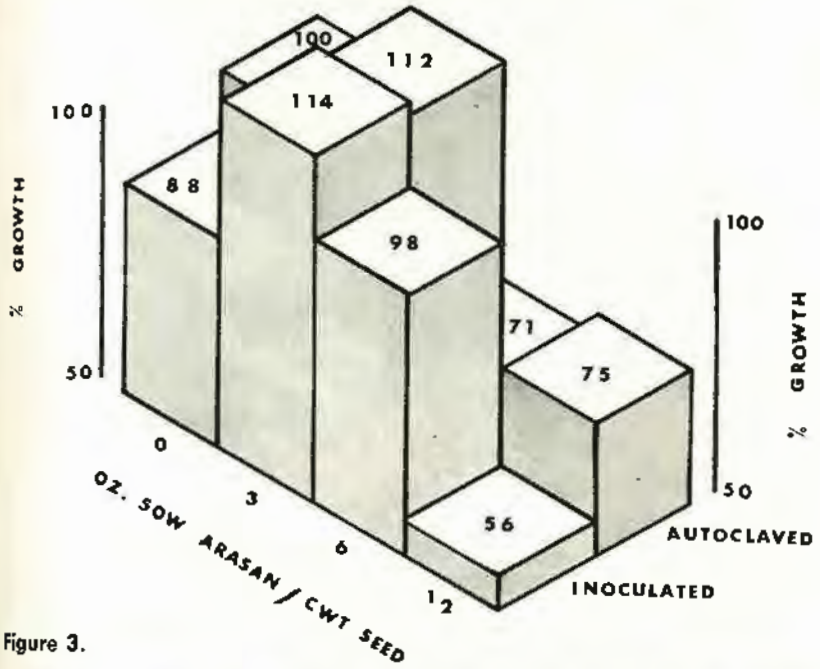


Figure 3.

Difolatan reduced pathogen effectiveness in the inoculated soil series when used at the recommended level of 2 oz./cwt. of seed (See Figure 4). An increase of 9 percent over the autoclaved check was obtained in this case. Reduced growth at higher fungicide levels was apparent and resulted from both reduced germination and less seedling vigor. Growth in the inoculated series was reduced to 89 and 14 percent of the autoclaved check with 4 and 8 ounces of Difolatan per cwt. of peanut seed, respectively.

Captan was the single exception of the fungicides used in this study with no apparent germination inhibition at even the highest fungicide level and with pathogen control also apparent at all levels (See Figure 5). Growth was greater than 90 percent of the autoclave check at the 8-ounce level of fungicide application.

A transparent packet soil-less type culture system was used to observe nondisturbed root systems as affected by *Aspergillus niger* infestation and fungicide treatment. The absence of soil materials and other microorganisms greatly restricted *A. niger* pathogenic activity as is apparent from the results shown in Table 1. Little difference was noted in com-

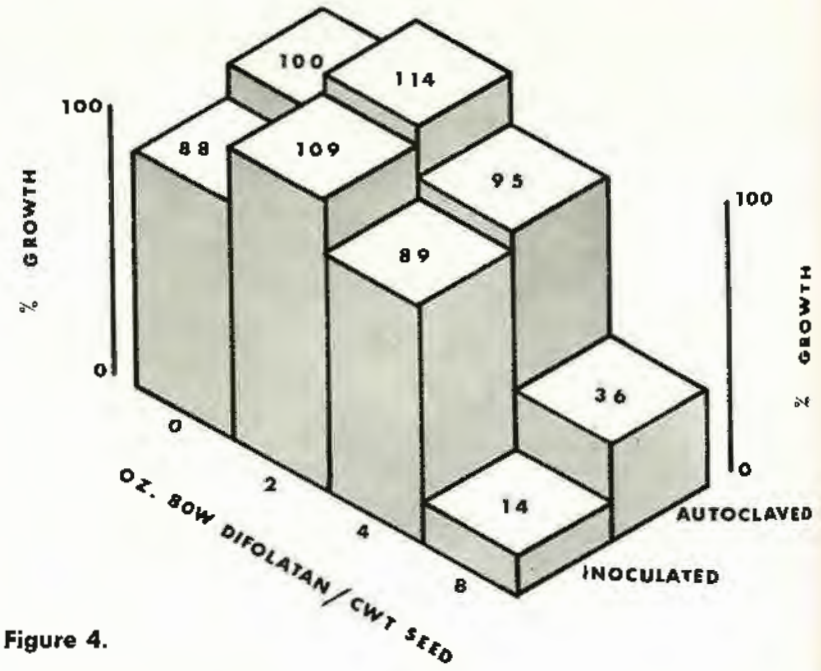


Figure 4.

paring growth with autoclaved and inoculated cultures but germination inhibition occurred with the high rate of Ceresan M.

Statistical analyses of results indicated good duplication in plant response apparent within replications and highly significant differences between treatments in all studies.

Results from these studies indicated that reasonable control of collar rot may be attained with the four fungicides when used at recommended rates. However only one, Captan, was apparently not inhibitory to germination at much higher application levels. Ceresan M was highly toxic to germination, and seedling development at all levels used higher than the recommended level for this fnngicide.

Table 1. Peanut growth in soil-less plastic bag cultures influenced by Aspergillus niger inoculations and differential fungicide treatments.

Treatment	oz./cwt. seed	Gm total dry plant weight per culture Autoclaved	*A. niger* inoculated
check	none	5.07	5.06
50W Captan	2	5.62	5.50
50W Captan	4	5.67	4.91
7.7% Ceresan M	1⅔	5.32	5.13
7.7% Ceresan M	3⅓	0.00	0.00
50W Arasan	3	5.51	5.20
50W Arasan	6	5.27	5.46
80W Difolatan	2	5.61	5.54
80W Difolatan	4	5.14	4.71

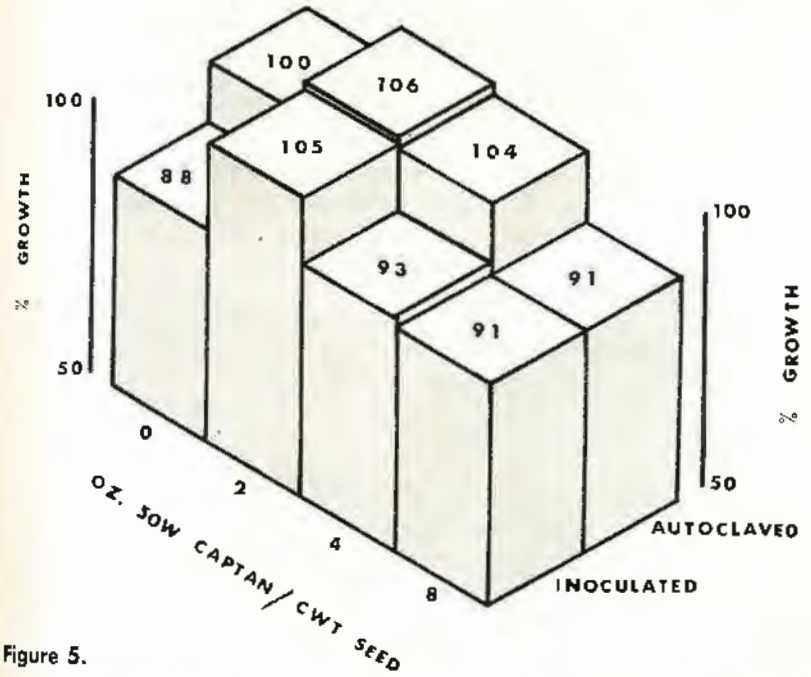


Figure 5.

Figure 2 - 5. Plant growth response expressed as percent of non-treated check (100%) grown on autoclaved soil. Inoculated soil series received viable spore and mycelia additions of A. niger, P. funiculosum, Fusarium sp., and Rhizoctonia sp. Results with fungicide materials are shown for Ceresan M in Figure 2, Arasan in Figure 3, Difolatan in Figure 4, and Captan in Figure 5.

LITERATURE CITED

1. Ashworth, L. J. Jr. 1963. *Aspergillus niger* seedling disease of Spanish peanut. Peanut Improvement Working Proceedings. pp. 178-181.
2. Ashworth, L. J. Jr., B. C. Langley, M. A. W. Mian, and C. J. Wrenn. 1964. Epidemiology of a seedling disease of Spanish peanut caused by *Aspergillus niger*. Phytopathology. 54:1161-1166.
3. Gibson, I. A. S. 1953. Crown rot, a seedling disease of ground nuts caused by *Aspergillus niger*. Trans. Brit. Mycol. Soc. 36:198-209.
4. Jackson, C. R. 1962. Aspergillus crown rot of peanut in Georgia. Plant Disease Reptr. 46:888-892.
5. Morwood, R. B. 1953. Peanut pre-emergence and crown rot investigations. Queensland Jour. Agri. Sci. 10:222-236.
6. Nema, K. B., A. C. Jain and R. P. Asthana. 1955. Further studies on Aspergillus blight of groundnut seedlings; its occurrence and control. Indian Phytopathology. 8:13-21.
7. Sturgen, R. V. 1964. Unpublished report of a fungicide study. Okla. Agric. Exp. Sta.

Peanut Rosette Virus Disease in Central Africa

R. W. Gibbons, J. A. K. Farrell and A. N. Adams
Agricultural Research Council of Central Africa,
Grain Legume Research Laboratory,
Lilongwe, Malawi

Introduction

The Grain Legume Research Team of the Agricnltural Research Council of Central Africa is situated at Chitedze in the Central Province of Malawi. The present function of this team is to study the virus and vectors of rosette, and to produce peanuts resistant to the disease. The *Cercospora* leafspots and other fungal diseases of peanuts are also being studied.

Peanut rosette virus has been known in Africa since 1907, when it was first described by Zimmerman in what is now Tanzania. Storey and Bottomley (1925, 1928) then reported the disease in South Africa, where it had apparently been known since 1909. They also discovered that *Aphis craccivora* Koch was a vector of rosette. Since then the disease has been recorded in most of Africa south of the Sahara, including Madagascar. Rosette has been reported from other parts of the world but these records have never been substantiated, and in some cases they have been found to be caused by other viruses (Gibbons and Adams unpublished).

Although some control can be obtained by cultural methods the ideal solution would be to produce peanuts resistant to the disease. This is important in view of the reluctance of African peasant farmers to adopt new methods, and because peanuts are often produced on very small farms which are difficult to mechanise because of tribal and economic reasons.

Characteristics of the Virus

There seems no doubt that several strains of rosette occur but little evidence is available on their inter-relationships. Storey and Ryland (1957) working in East Africa showed that at least two rosette strains were present viz. chlorosis which canses severe stunting and leaf distortion; and mottle, which causes little or no stunting with leaves showing a mottle of normal and slightly pale green areas. Cross protection tests indicated that these strains were related. When simultaneous injection of these two strains into the peanut occurred mosaic symptoms were produced. Two other viruses causing mild mottle symptoms were discovered but cross protection tests indicated that they were not related to rosette.

In West Africa Hayes (1932) described a green rosette in the Gambia and a similar form is commonly found in Nigeria. Although no experimental work on the relationships of West African green rosette has been reported it is interesting to note that it is transmitted by *A. craccivora* in a similar manner to our strains of rosette, and resistance only occurs in the same varieties of peanuts (Harkness unpublished). Recently Klesser (1965) has reported green rosette, as well as chlorosis and mosaic, in South Africa. A veinbanding symptom was also recorded by her and she believes this is also a strain of rosette. In Malawi chlorosis and mosaic are commonly found but mild mottle has not so far been observed, but if our strains are the same as those described by Storey and Ryland (1957) then the presence of these two symptoms indicate the presence of the third, as chlorosis plus mottle gives mosaic.

No rosette strain has so far been isolated and the detection of the disease must at the moment rely on the following criteria viz. symptom expression and reaction of various varieties, transmission by *A. craccivora* in a persistent manner, difficulty of mechanical transmission (low rates have been achieved by etiolation of the recipient plant for 48 hours and the use of carborundum), lack of seed transmission and details of the acquisition and infection feeds. Not all strains of *A. craccivora* are capable of transmitting rosette. We therefore cannot be certain that we are dealing with the same viruses found in other parts of Africa. At the Virus Research Unit (Agricultural Research Council of Great Britain) in Cambridge, England, Dr. R. Hull is attempting to isolate rosette strains from Africa and to determine their inter-relationships.

Recently, Adams (1966) has shown that in Malawi under laboratory conditions *Aphis gossypii* Glov. can transmit our rosette strains with very low efficiency. Several collections of this aphid all transmitted at the same low rate.

Two other suspected viruses of peanuts are at present under investigation. One, a mottle, has only been transmitted so far by grafting. The other, a mosaic, was transmitted from tobacco by *Myzus persicae* Sulz.

Alternate Hosts of the Virus

In Malawi the peanut growing season lasts from November until May. At Chitedze the average rainfall is about 32 inches a year and only 4 percent of this falls in the seven dry months. During this dry season volunteer peanuts rarely survive in the Central Province which is the main producing area. Seventeen dry season hosts of *A. craccivora*, mostly perennail legumes, have been tested and shown not to be hosts for the virus. Colonies of *A. gossypii* from 29 host species were transferred to peanuts and also failed to transmit the virus. Although these tests are inconclusive in the search for a local alternative host of the virus, it is possible that long distance migration of aphids carrying the virus

takes place from other areas, possibly where dry season survival of volunteer peanuts may occur.

Genera related to *Arachis* such as *Zornia* and *Stylosanthes*, have also been tested as virus hosts. So far *S. gracilis*, *S. sundaica* and *S. mucronata* have been confirmed as rosette virus hosts. *A. craccivora* retransmitted the virus from *S. gracilis* and *S. sundaica* but not from *S. mucronata*, although it fed and multiplied on it during the acquisition feed. However, re-transmission from *S. mucronata* by grafting onto peanuts showed the presence of the virus. *S. gracilis* is regarded as a promising pasture legume in Malawi. *Trifolium incarnatum* is also a host and *A. craccivora* can retransmit the virus from it to peanuts.

Yield Loss Due to Rosette

Yield reduction in rosetted plants has been studied in the Upper-Volta by Berchoux (1960). He found that yield loss varies with time of symptom expression, being almost total in plants diseased during the first third of the season, and uegligable in those infected during the last third. These results have been confirmed over three seasons at Chitedze.

The effects of chlorosis are significantly more severe than mosaic in yield reduction of early infected plants. Yield loss is relatively less in late sown plants of low productivity.

Testing Techniques for Resistance

The standard testing technique employed at Chitedze is to feed 5 infective adult apterous aphids on 14-21 day old test plants for 24 hours. (Gibbons and Farrell, 1966). Symptoms are usually prodnced on susceptible varieties in the glasshouse in 10-20 days. Previous methods using germinating seeds as test plants were found to be unreliable. Field testing for varietal resistance to rosette is also unreliable as infection may be light, and susceptible varieties may remain disease free necessitating re-testing the next season. A search for resistance in Spanish and Valencia peanuts obtained from a wide range of countries has not been successful.

Sources of Resistance

Evans (1956) showed that some East African peanuts have a certain amount of field resistance to rosette. Under laboratory conditions the plants became infected normally but the aphids reproduced more slowly and so in the field less secondary spread took place. The only true source of genetic resistance to rosette comes from West Africa. The original source of the resistant lines was north of the Ivory Coast, but they were actually tested at Bambey in Senegal. Further searches in the Upper-Volta produced some more resistant lines. All these resistant varieties would be

classified as Castle Cary Bunch types according to Bunting (1955), or runners on the U.S.A. system. Berchoux (1960) working on these varieties found that resistance was governed by two recessive genes. This means that in crosses between resistant and susceptible varieties the F_1 hybrid is susceptible to rosette and must be protected from the disease. At Chitedze we grow these F_1 plants in fan cooled insect free glasshouses. The F_2 segregates out into a ratio of 15 susceptible: 1 resistant plant, so to increase the supply of F_2 seed vegetative cuttings are taken from F_1 plants. We have now harvested our first batch of F_1 plants and the F_2 progenies will be tested under controlled conditions for resistance. This hybridization scheme is necessary because in most parts of Africa where these resistant varieties have been tested they are low yielding, and take too long to mature for release to farmers. Our aim is to combine this resistance with the high yield of the locally adapted but susceptible varieties.

Nutman *et al* (1964), previous workers in this team, confirmed the resistance of these West African varieties to strains of rosette present in Malawi. They found that these varieties were not immune but highly resistant. It was demonstrated by grafting tests that they acted as symptomless carriers of the virus when infected by aphids. Retransmission by non-infected aphids from these symptomless carriers failed, presumably because the virus was in such a dilute state in the plant. Only when rosetted scions were grafted onto the resistant varieties did symptoms appear, but even then symptom expression was mild and much delayed.

A collection of wild *Arachis* species have been tested to see if immunity to the disease occurs in the genus. Typical rosette symptoms appeared after vector feeding tests in the tetraploid *A. monticola* and the diploids, *A. villosulicarpa*, *A. batizocae*, *A. rigonii*, *A. duranensis* and the presently unnamed *A. sp. 10038*. Two further species appear to be immune to rosette although confirmation of this is still required. They are *A. glabrata*, a tetraploid rhizomatous perennial, and *A. repens*, a diploid perennial stoloniferous species. At Chitedze after four separate infection feeds by groups of viruliferous aphids no symptoms were produced. Scions of cultivated peanuts grafted onto these stocks of *A. glabrata* and *A. repens* also failed to produce symptoms indicating that these species were not even symptomless carriers of the virus. Further tests included grafting rosetted scions onto stocks of the two species. Symptoms again did not appear and back grafts to healthy peanut stocks failed to transmit the disease. Storey and Jennings (1952-55) had also thought that these two species were probably immune but their *A. repens* had been wrongly identified as *A. prostrata*. This re-identification was carried out at Chitedze where a duplicate set of their collection was received in 1964. Unfortunately nobody has yet obtained viable hybrids between these two species and the cultivated peanut. However, these species may

have a use as pasture legumes in Africa and it is essential that no species of *Arachis* should be released which are susceptible to rosette. If a perennial source of the virus was available then infection of cultivated peanuts may increase. Recently *A. glabrata* (PI 118457) has been released in Florida as a pasture legume (Blickensderfer *et al* 1964).

Field Epidemiology

Observations over three years at Chitedze suggest that winged *A. craccivora* invade the crop in numbers from approximately 50 days after one inch of rain has fallen in the growing season. A marked increase in rosette follows this invasion, which is assumed to include infective aphids transmitting rosette to peanuts.

Colonies of aphids build up on rosetted plants, from which the virus may be transmitted to neighbouring plants by migrating wingless adults. Normally this type of secondary spread is of limited extent, but occasionally large patches, up to 20 feet in diameter, of rosetted plants occur. Usually these patches show uniform rosette symptoms, suggesting that spread from a single source plant, supporting an unusually large number of aphids, has occurred.

Numbers of invading winged aphids found in the crop appear to vary with plant age. Plants 20-30 days old may be infested with 3 to 5 times as many winged aphids as plants 50-60 days old, with corresponding differences in rosette incidence. It is not known yet whether this difference is due to a landing or settling response, or both, on the part of the aphids. Thus early planting of peanuts, producing older and less attractive plants at the time of the aphid invasion, results in a marked reduction of rosette incidence.

Numbers of invading winged aphids also vary with crop density. Over twice as many occur in open (3 plants/sq. yard), as in dense (30 plants/sq. yard) peanuts. Field observations on 10-25 day old plants showed that while similar numbers of aphids landed on the two crop densities, twice as many settled on the open as on the dense plants. Rosette is transmitted to peanuts in an infection feed of 1-9 hours under laboratory conditions so that only aphids settling for some time can be expected to transmit the virns.

Early rosette incidence varies with the numbers of invading winged aphids, so that not only is the proportion of rosetted plants reduced by "dilution" at high plant populations, but also incidence per unit area is reduced. Secondary spread within the crop is slower in dense peanuts, where the numbers of potential vectors per rosetted plant are reduced. This is partly the effect of plant population, where aphid numbers per plant will decrease as the plant population increases and partly due to a reduction of aphid numbers per unit area in the dense crop. This reduction, which may be described as culturally induced resistance to the aphid, has been found in field experiments over three seasons, and is the subject of further investigation.

The duration of rosette spread is limited by plant maturity when aphid colonization ceases. Symptom expression is suppressed in the absence of new leaf production when vegetative growth ceases. More rapid maturity in early and dense planted peanuts thus further reduces rosette incidence.

At Chitedze these factors give rise to a great variation in rosette incidence per unit area, from 100-200 per acre in a dense early sown crop to 3000-5000 per acre in an open, late sown crop.

LITERATURE CITED

ADAMS, A. N. 1966. Groundnut rosette virus - another vector. Rhod. Zamb. Mal. J. Agric. Res. (in press).

BERCHOUX, C. de. 1960. Groundnut rosette in the Upper-Volta; behaviour of resistant varieties. Oleagineux 15: 229-33.

BLICKENSDERFER *et al* 1964. Wild peanut is promising forage legume for Florida. Crops and Soils 17(2): 19-20.

BUNTING, A. H. 1955. A classification of cultivated groundnuts. Emp. J. Expt. Agric. 23(91/92): 158-170.

EVANS, A. C. 1956. A study of rosette resistant groundnut variety Asirya Mwitunde. E. Afri. agric. J. 22: 27-31.

GIBBONS, R. W. and FARRELL, J. A. K. 1966. Test plant age and the transmission of groundnut rosette virus by the vector *Aphis craccivora* Koch. Rhod. Zamb. Mal. J. agric. Res. 4: 23-28.

HAYES, R. T. 1932. Groundnut rosette disease in the Gambia. Trop. Agric. Trin. 9: 211-17.

KLESSER, P. J. 1965. Groundnut variety trials for reaistance to virus diseases. Tech. Comm. No. 42. Dep. Agric. Tech. Ser. S. Africa. 1-17.

NUTMAN, F. J., ROBERTS, F. M. and WILLIAMSON, J. G. 1964. Studies on varietal resistance in the groundnut, (*Arachis hypogaea* L.) to rosette disease. Rhod. J. Agric. Res. 2: 63-77.

STOREY, H. H., and BOTTOMLEY, A. M. 1925. Transmisaion of rosette disease of the groundnut. Nature, Lond. 116:97-98.

STOREY, H. H,. and BOTTOMLEY, A. M. 1928. Rosette disease of peanuts. Ann. appl. Biol. 15:26-45.

STOREY, H. H., and JENNINGS, D. L. 1952-1955. Ann repts. E. A. Agric. & For. Res. Org.

STOREY, H. H., and RYLAND, A. K. 1957. Viruses causing rosette and other diseases in groundnuts. Ann. appl. Biol. 45: 318-326.

Inactivation and Removal of Aflatoxin[1]

by

F. G. Dollear and H. K. Gardner, Jr.[2]
Southern Regional Research Laboratory[3]
New Orleans, Louisiana

The inactivation or removal of aflatoxins from oilseed products is one of the most challenging problems in research at the Southern Utilization Research and Development Division (SU). Aflatoxins may be produced by certain species of molds when conditions are suitable for their growth on peanuts, oilseeds, and other agricultural products commonly used for food or feed. This has made necessary the use of aflatoxin analyses for quality control. Peanut meals containing more than 30 parts per billion of aflatoxins have been diverted to fertilizer markets at greatly reduced economic return, fertilizer-grade meal bringing only about $20 to $30 per ton. The removal of such a small qnantity of material dispersed in a large amonnt of meal poses a real problem.

The peanut processors are doing a good job of culling out undesirable peanuts from peanuts for food use. The objective of research in this area at SU is primarily inactivatiou or removal of aflatoxin from lower grade peanuts milled for oil and meal aud from cottonseed meal. Since there were conflicting reports iu the literatnre on the effect of heat on aflatoxin, one of the first problems was to study the effect of heat and moisture under laboratory conditions simulating those which might be encountered in commercial processing. For this investigation a cottonseed meal containing 144 parts per billion of aflatoxin B_1 was chosen. Five hundred grams of meal was charged into a small bench-scale steam-jacketed cooker with an efficient agitator and the moisture content adjusted by adding water. The temperature was brought up to 100° C. and various batches cooked for periods of time from 30 minutes up to 150 minutes. The effect of heat and moisture on destruction of aflatoxin is illustrated in Figure 1. As shown by the upper curve, cooking at 6.6 percent moisture did not greatly reduce the aflatoxin content. However, at moisture contents of 15, 20, or 30 percent, aflatoxin content after two and one-half hours heating was reduced to less than 25 percent of the original level. It is apparent from these curves that although increased moisture content results in increased destruction of aflatoxin, heat and moisture aloue do not supply a very satisfactory method to inactivate or

[1]Presented in part by each author at the Fourth National Peanut Research Conference, Tifton, Ga., July 14-15, 1966.
[2]The authors wish to acknowledge the technical aseistance of their coworkers, Godfrey E. Mann, Stanley P. Koltun, and Louis P. Codifer, and the advice and encouragement of Leo A. Goldblatt and H. L. E. Vix.
[3]One of the laboratories of the Southern Utilization Research and Development Division, ARS, USDA.

remove aflatoxin from oilseed meals. Chemical approaches to inactivation of aflatoxin were next investigated. Examination of the structure of aflatoxins shown in Figure 2 provides some clues to chemical treatments that might be effective. All four aflatoxins B_1, B_2, G_1, and G_2 have lactone rings. These are inner-esters and should be susceptible to hydrolytic treatments to open up the rings. Treatment with a base, for example, should result in the formation of soaps which in themselves may be less toxic than the original compounds. Chemically this would be analogous to treating oil with alkali to convert the glyceride ester to soaps of the fatty acids.

Aflatoxins B_1 and G_1 have a double bond which is readily attacked by oxidizing or reducing agents. This is a point of attack for oxidizing agents, some of which also are worthy of investigation. There are points of unsaturation even in aflatoxin B_2 and G_2 but these bonds may not be as readily attacked by oxidizing agents. Some evidence indicates this to be the case.

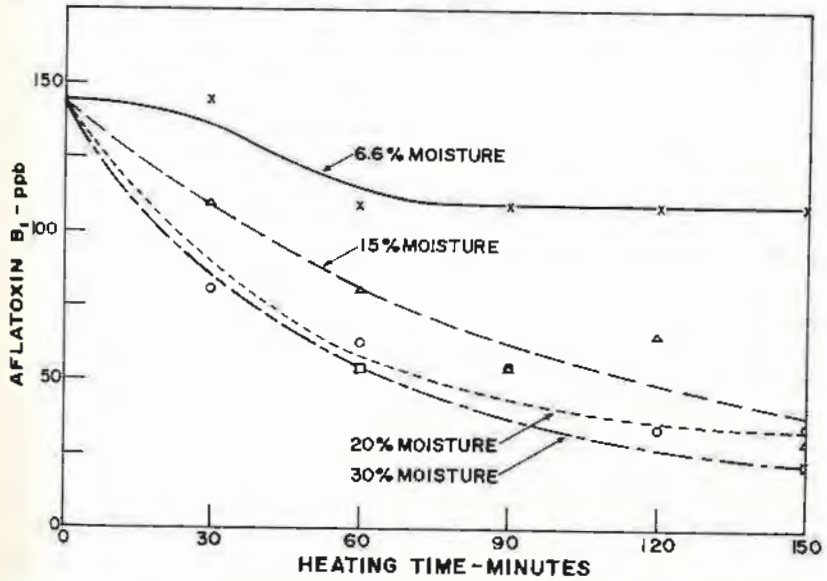


Figure 1. Rate of Aflatoxin B_1 Destruction in a Cottonseed Meal at 100°C.

Screening of Various Chemicals

A study was initiated to screen various chemical reagents—acids, bases, salts, and oxidizing and reducing agents to determine if we could eliminate or inactivate aflatoxin by chemical treatment. Inactivation of aflatoxin was determined by analytical separation of the aflatoxins using procedures worked out for thin layer chromatographic analysis and comparison of their ultraviolet fluorescence with standards. Seven hundred grams of meal

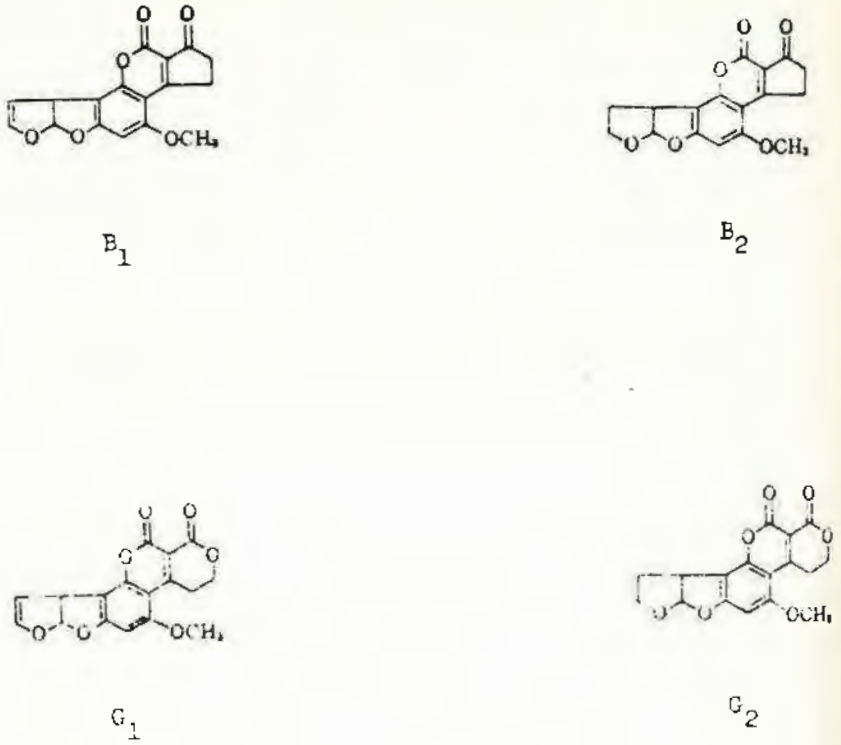


Figure 2. Aflatoxin Structures

was a convenient sample to use in the cooker described above. The meals, or flaked seed, were mixed with various amounts of water and with a chemical reagent in a Hobart mixer to assure good contact with the reagent. This mixture was then charged into the cooker. For the initial screening studies, time and temperature of the reactions or cooks were kept constant at two hours and 100° C., respectively. Controls were run by cooking at the same moisture content but without added chemicals. The results of these screening operations may be grouped into three classes: chemicals which were relatively ineffective, those which were moderately effective, and those which were promising. Relatively ineffective were: choline chloride, triethylamine hydrochloride, 2-diethylaminoethanol, sodium sulfite, dextrose and fructose. Moderately effective were: 3-aminopropanol, glycine with sodinm hydroxide, 1-amino-2-propanol, trisodium phosphate, phosphoric acid, calcium hydroxide and ammoninm carbonate. Promising results were obtained with methylamine, ethanolamine, trimethylamine hydrochloride plus sodium hydroxide, choline, and sodium hydroxide. Experiments with ozone have also indicated that it may be a promising treatment. Based on screening results, further work has been done with two of the reagents which seem most effective: methylamine and sodium hydroxide. Each of these has been stndied with aflatoxin-contaminated cottonseed and peanut meals to establish the minimum conditions of concentration, moistnre content, and heat, for aflatoxin elimination. Time does not permit giving details of all of these experiments so only those conditions which were found best will be discussed. Illustrative of the best results obtained are experiments where meals were cooked at 100° C. for two hours with various reagents.

Methylamine Treatment

Peanut meal was prepared from pickout peanuts having an extremely high aflatoxin content—2850 ppb of aflatoxin B_1, 4000 ppb of total aflatoxins. This meal was adjusted to 15 percent moisture and cooked with 1.25 percent methylamine. Aflatoxin B_1 was reduced to 63 ppb and total aflatoxins to 65 ppb.

Cottonseed flakes, from which the oil had not been removed, selected for their unusually high aflatoxin content, 540 ppb B_1 and 760 ppb total aflatoxins were heated with 15 percent moisture. The aflatoxins were reduced about 50 percent, that is, to 217 ppb B_1 and 325 ppb total. With 1.25 percent methylamine and 15 percent moisture, the B_1 content was reduced to 0 to 5 ppb and the B_2 content to 0 to 11 ppb.

Cottonseed meal having an original aflatoxin B_1 content of 130 ppb and a total of 200 ppb was heated with 22 percent moisture alone reducing the aflatoxin content to 103 ppb of B_1 and a total of 137 ppb. With 1.25 percent methylamine and 15 percent water, the B_1 content was reduced to 14 ppb and the B_2 was not readable.

Sodium Hydroxide Treatment

A peanut meal containing 68 ppb B_1, and 113 ppb total aflatoxins was cooked with 22 percent moisture alone which reduced the aflatoxin content to 47 ppb B_1, and 75 ppb total. When cooked with 2 percent sodium hydroxide and 22 percent moistnre, the B_1 content was redneed to 11 ppb and total aflatoxins to 18 ppb. When cooked with 2 percent sodium hydroxide and 30 percent moisture, only a trace of B_1 remained, no B_2 was discernible, and four ppb of G_1 was detected.

Based on these findings, which are indeed quite promising, larger batches of treated meal are being prepared for biological assay of aflatoxins with ducklings. If these biological tests confirm that the toxicity has indeed been removed, then feeding tests to determine nutritional value will he carried out cooperatively by the Western Utilization Research and Development Division. Further research will he necessary to scale up the most promising of the inactivation treatments for application in commercial oil mills. Mr. Gardner will present information on other

methods of treatment which are being investigated at the Southern Division.

Mr. Dollear has presented the aflatoxin problem and outlined some approaches to its solution. This part of the presentation will deal with three areas of aflatoxin deactivation or removal. They are: the physical separation of contaminated from uncontaminated peanuts and cottonseed, ammoniation as a means of deactivation of aflatoxin in peanut and cottonseed meals, and solvent extraction techniques as a means of removal of aflatoxin in peanut and cottonseed meats and meals.

Engineering research at SU has been geared to develop concurrently techniques and procedures which will be applicable to the three basic types of extraction for peanuts and cottonseed, screw press, prepress-solvent, and direct solvent.

Physical Separation

The peanut industry has made good progress through the use of culling devices such as photoelectric sorters, in the removal of contaminated peanuts from the bulk of the non-infected. Cooperatively Anderson, Clayton and Company, the Agricultural Research Center, Stanford Research Institute (SRI), and SU have carried out at SRI experiments with a zig-zag type separator used successfully to separate non-viable cottonseed from viable seed based on density. This equipment has shown some promise in segregating contaminated from uncontaminated peanuts.[3] So far the technique has produced three fractions out of a five-fraction separation that are essentially free of aflatoxin. Additional separation work on peanuts is being carried out there.

The Stanford technique has not proven satisfactory in the separation of a single lot of cottonseed, either delintered or undelintered, into contaminated and uncontaminated fractions. All fractions produced from this single lot of seed have had essentially the same level of aflatoxin. The reason postulated for not achieving separation was that the seed had been subjected to biological heating in the storage pile and thus the mold, and the resulting aflatoxin, had spread throughout the whole mass of seed. Stanford Research Institute believes, however, that separation of contaminated and uncontaminated cottonseed might still be possible provided the seed is obtained before the mold and the aflatoxin have had time to diffuse throughout the lot.[3]

Cottonseed has been separated also on the basis of its density and ballistic characteristics at SU. Initial correlation of seed density with aflatoxin contamination gave encouraging results. For example, in the first separation experiment, a delintered cottonseed containing 40-80 ppb of aflatoxin B_1 was used. Over 63 percent of the aflatoxin B_1 was concentrated in about 6 percent of the seed, and about 85 percent concentrated in 25 percent of the seed as shown in Figure 3. While this was not a sophisticated separation technique and probably did not give sharp separation of the fractions, it did suggest a marked segregation effect by seed quality and aflatoxin content. The data seem to substantiate the hypothesis that seed of high fatty acids content and of least density were likely to be those of highest aflatoxin content. In another separation experiment, a sample from the same lot of cottonseed as used in the SRI test containing about 1000 ppb total aflatoxin was projected both as delintered and undelintered seed. Little or no segregation was achieved as shown in Figure 4. Based on these results, work on the projection technique was temporarily discontinued. However, in light of findings with the SRI zig-zag separator and results at SU with this particular seed, re-examination of the projection technique of seed separation seems to be in order.

Several aflatoxin-contaminated cottonseed and peanut meals were fractionated by screening with a number of sieves ranging in size from 20-mesh to 200-mesh. Analyses of these fractions indicated that essentially the same level of aflatoxin was present in each fraction as in the original meal. Therefore, this type of fractionation does not appear promising as a means of aflatoxin removal.

[3]Private communication.

Chemical Inactivation with Ammonia

Both anhydrous ammonia and ammonium hydroxide offer promise in reducing aflatoxin in oilseed meals. The results obtained with anhydrous ammonia on meals under various conditions of time, temperature, pressure, moisture, and ammonia concentration are shown in Table 1. Cottonseed meal A and peanut meal B were ammoniated as received. Peanut

Table 1. Ammoniation of cottonseed and peanut meals.[1]

Meal	A Cottonseed	B Peanut	C Peanut	D Peanut	E Peanut	F Peanut
Aflatoxin, B_1 PPB	144	709	709	709	2600	64
, Total PPB	187	1020	1020	1020	4174	110
Reaction Conditions						
NH_3 Conc., %[a]	4.7	3.0	3.0	7.2	6.7	6.7
Meal Moist. Content, %	6.6	4.0	9.6	14.6	15.0	15.0
Temperature, °F	178	160	150	160	178	163
NH_3 Pressure, PSIG	40	20	25	40	40	43
Time, Minutes	60	70	15	60	15	15
Aflatoxin in Treated Meals						
Aflatoxin, B_1 PPB	N.D.[b]	203	25	17	17	T[c]
Reduction %	100	71	96	98	99+	99+
Aflatoxin, Total PPB	N.D.[b]	377	39	24	34	T[c]
Reduction %	100	63	96	98	99+	99+

[1]Anhydrous Ammonia
[a]Theoretical concentration - weight of anhydrous ammonia introduced into reactor per weight of meal treated. Reactor about ¼ filled with meal.
[b]None Detected
[c]Trace Detected

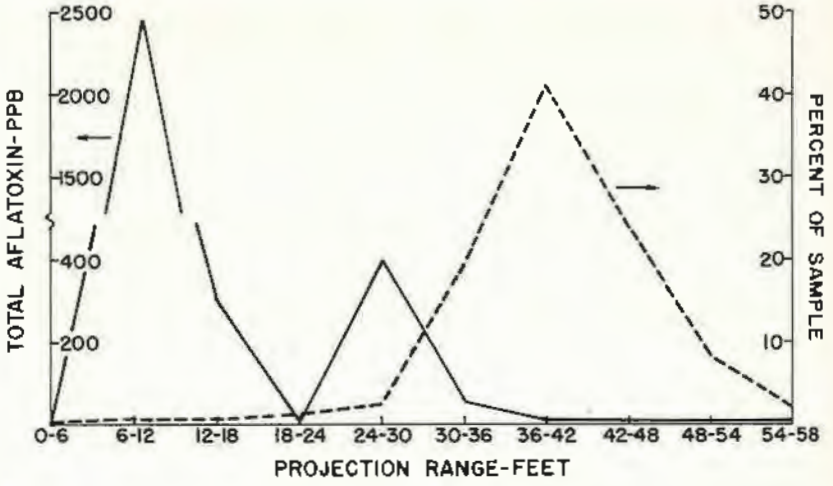


Figure 3. Aflatoxin in Projected Cottonseed (Assay of Composite, 40-80 PPB)

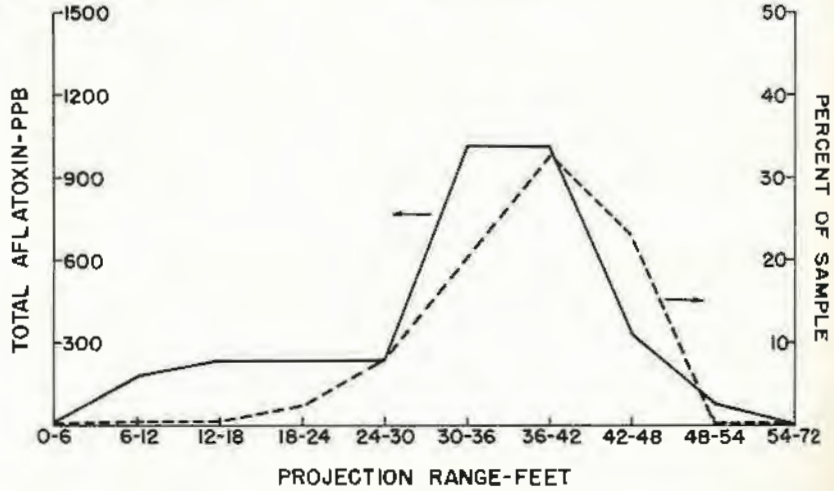


Figure 4. Aflatoxin in Projected Cottonseed (Assay of Composite, 750 PPB)

meals C, D, E, and F were premoistened to 9.6, 14.6, 15, and 15 percent, respectively, prior to ammoniation. Under the conditions to which meal A was subjected, no aflatoxin was detected in the product by chemical assay. Of meals B, C, and D containing 709 ppb of aflatoxin B_1, meal D was given the most severe treatment. However, all conditions evaluated were still quite mild. It will be noted that the aflatoxin B_1 content was reduced by 71 and 96 percent, respectively, in meals B and C. Both treated meals

contained more than 30 ppb total aflatoxin content. In meal D, the residnal aflatoxin in the treated meal was 17 ppb of B_1. This constitutes a 98 percent reduction in aflatoxin B_1. The total aflatoxin was less than 30 ppb for this meal D.

Peanut meal E produced from peanut pickouts and assayed 2600 ppb of aflatoxin B_1 was ammoniated under conditions which were thought to contribute most to the aflatoxin reductions achieved with meals A and D but with a shorter contact time. This ammoniation treatment reduced the aflatoxin content by more than 99 percent, down to 17 ppb of aflatoxin B_1 and 34 ppb total aflatoxin. Meal F was ammoniated under conditions similar to that used for meal E. Only trace qnantities of aflatoxin were detected.

Indications are that the nutritive quality of ammoniated cottonseed and peanut meals (0.03-0.6 percent increase in nitrogen) is not appreciably degraded when these meals are chemically analyzed for lysine (E.A.F.) and nitrogen solubility, Table 2.

Table 2. Effect of ammoniation on selected meal analyses.[1]

Meal	A Cottonseed	B Peanut	C Peanut	D Peanut	E Peanut	F Peanut
Nitrogen, %						
Initial	6.56	9.33	9.33	9.33		9.11
Final	7.13	9.61	9.89	9.72		9.57
Change	+0.57	+0.28	+0.56	+0.39		+0.46
Nitrogen Solubility, %						
Initial	71.80	96.68	96.68	96.68		82.44
Final	58.06	98.86	84.43	91.05		70.01
Change	-13.74	+2.18	-12.25	-5.63		-12.43
E.A.F. Lysine G/16 G.N						
Initial	2.74	2.97	2.97	2.97		2.78
Final	2.57	2.87	2.70	2.73		2.67
Change	-0.17	-0.10	-0.27	-0.24		-0.11

[1]Anhydrous Ammonia

In cooperation with an equipment manufacturer, continuous ammoniation of a commercial peanut meal of restricted grade was attempted using a pilot plant sized grain expander. The experiment was not entirely satisfactory. The best conditions of time, temperature, pressure, moisture, and ammonia concentration reduced the aflatoxin by about 50 percent. The failure to achieve better reduction of the aflatoxin can probably be attributed to the lack of intimate mixing of the meal and ammonia prior to the build-up of pressure within the expander and to the very short contact time of about 30 seconds. More work is planned along these lines.

Anhydrous ammoniation of comminuted peanut meats followed by flaking and solvent extraction did not achieve reduction in aflatoxin comparable to that achieved when meals were ammoniated. Apparently, the oil masks, or interferes with, the effect of ammonia on the aflatoxin. Similar

results have been observed when some of the other treatments have been used where significant amounts of oil were present in both meals and meats.

Ammonium hydroxide treatments were carried out with cottonseed meals in exploratory storage studies. The cottonseed meal assaying 144 ppb aflatoxin B_1 and 43 ppb aflatoxin B_2 was treated with 2¼ percent of 30 percent ammonium hydroxide based on the weight of meal. The samples were stored in sealed containers for periods up to 14 days. The storage temperatures were: ambient (70-80° F.), and 100° F., and 150° F. Three meal moisture levels were included, 5, 10, and 15 percent. The only appreciable reduction in aflatoxin occurred after 14 days at 150° F. in the meal sample containing 15 percent moisture content. Aflatoxin B_1 was reduced by 85 percent, the total aflatoxin, by 80 percent.

The study was extended to cover a threefold increase in ammonium hydroxide added to the meal at two moisture levels, 7.8 and 15 percent. These samples were stored at two temperatures, 150 and 200° F., for two and seven days in sealed containers. After two days at 150° F., only the meal containing 15 percent moisture showed any appreciable reduction, about 55 percent. After two days at 200° F., aflatoxin in both samples was reduced by about 93 percent. Little additional reduction was noted after seven days.

Aflatoxin Removal by Solvent Extraction

Several possibilities exist for the use of solvent extraction techniques to reduce aflatoxin in oilseed products. They are (1) the simnltaneous extraction of oil and aflatoxin from flaked meats or prepress cake with such solvents as acetone-hexane-water mixture and 90-95 percent aqueous acetone, (2) the extraction of aflatoxin from meals using the above solvents; and (3) the selective extraction of aflatoxin from flaked meats with 70 percent aqueous acetone prior to conventional oil extraction.

In this research program, some of the above techniques have been investigated. Preliminary results are as follows:

1. Prepressed peanut cake assaying 300 ppb aflatoxin and containing 10-12 percent oil was extracted with a mixed solvent made up of 54 percent acetone, 44 percent hexane, and 2 percent water by weight. The extraction was carried out in a pilot plant continuous immersion type extractor. The extraction time was about 70 minutes. The solvent to meats ratio was about 1.5 to 1 with the solvent heated to 100-105° F. The extraction followed by desolventization removed about 90 percent of the aflatoxin and produced a meal with 1-2 percent residual oil.

2. In small scale pilot plant extractions using 90 percent aqueous acetone heated to about 120° F. as the solvent, total aflatoxins in a cottonseed meal (180-190 ppb) and a peanut meal (80-90 ppb) were reduced to 13 and 11 ppb, respectively. Based on these results a peanut meal assaying 256 ppb aflatoxins was extracted with 90 percent aqueous acetone in continuous pilot plant equipment. Extraction conditions and equipment simulated that found in the peanut industry. The peanut meal was obtained directly from the desolventizers. The particle size distribution of the meal ranged from 51 percent on a 20-mesh screen to 5 percent through 100-mesh. No processing difficulties were encountered in extraction, miscella filtration, desolventization or solvent recovery. Approximately 75 percent of the total aflatoxin was removed. Although the extracted meal did not meet the 30 ppb total aflatoxin criteria, the results were encouraging. By making some adjustments in extraction time, solvent temperature and particle size of the meal, a reduction in total aflatoxin of 87 percent has been achieved.

In batch solvent extraction operations, a mixed solvent (56 percent acetone, 42 percent hexane, and 2 percent water by weight) has also been used successfully to reduce the total aflatoxin in a peanut meal assaying 1000 ppb by 98-99 percent. The meal to solvent ratio was 1 to 3.

3. Selective extraction of aflatoxin in cottonseed flakes assaying 500-600 ppb with 70 percent aqueous acetone reduced the aflatoxin by 96-98 percent. The flaked meats were first slurried for 30 minutes in the aqueous acetone, the slurry filtered, and the resultant cake washed twice with aqueous acetone. This procedure extracts only 1-3 percent of the oil. Consequently, conventional oil extraction followed. In addition to extracting the aflatoxin, the 70 percent aqueous acetone removes most of the free gossypol, about 75 percent of the free-fatty acids, and leaves essentially neutral oil in the meats.

Although considerable progress has been made in research on the removal and deactivation of aflatoxins in oilseed products, an acceptable procedure cannot yet be recommended to industry. Further engineering on the processes as well as testing of the treated products, both biologically and nutritionally, is needed.

Abstracts of Talks Presented

Predicting Optimum Harvest Date of Peanuts from Meteorological Factors

V. J. Valli
Advisory Agricultural Meteorologist
U. S. Department of Commerce, ESSA
Weather Bureau Agricultural Service Office
Coastal Plain Experiment Station
Tifton, Georgia

Five indicies of plaot growth and development are examined for ability to predict maturity of six varieties of peanuts. These indicies are: (1) Growing Degree Days above a base of 65° F.; (2) Effective Heat Units with a lower cardinal temperature of 56° F. and an optimum cardinal temperature of 76° F.; (3) Effective Radiation (black bulb daily mean temperature times day length divided by ten); (4) Radiation in Langleys; (5) Effective Langleys (Langleys times the daily meao temperature).

Of the five indicies, based on the standard deviation in days and the coefficient of variation, the Effective Langleys index was tbe best single predictor of peanut maturity. Accumulations of Effective Langleys, from planting to maturity, varied between varieties as follows: Dixie Spanish: 39,700; Early Runner, Virginia Bunch 67, and Virginia Bunch G2: 47,000; Dixie Runner and Southeastern Runner 56-15: 50,000.

A Promising Method for Control of Nutsedge in Peanuts[1]

Ellis W. Hauser
Research Agronomist
Crops Research Division
Agricultural Research Service
U. S. Department of Agriculture
Tifton, Georgia

Perennial nutsedges (*Cyprus esculentus* L., yellow nutsedge, and *C. rotundus* L., purple nutsedge) are the most troublesome weeds in peanuts grown in Georgia. The acreage infested witb nutsedge is increasing. Mechanical control of nutsedge is not effective in wet years when cultivation is difficult. However, even in drier seasons, control of heavy infestations by cultivation is inadequate.

Nutsedges compete with peanuts for moisture, nutrients, air, and light. They interfere with mechanical harvesting, and the tubers contaminate both edible and seed peanuts, thereby lowering peanut quality. Consequently, nutsedges threaten farmers, processors, manufacturers, and consumers.

Vernolate (*S*-propyl dipropylthiocarbamate), a volatile thiocarbamate herbicide, appears especially promising for the control of nutsedges and many other weeds in peanuts. Disk harrows and rotary tillers are commonly used to incorporate tbis herbicide in the soil, thus, reducing its vaporization into the atmosphere.

A promising new technique is placement of herbicides beoeath the soil surface in thin horizontal layers (subsurface bands). Special applicators (V-shaped blades or covered sweeps) produce a moving canopy of soil under which herbicides are applied from fan-type nozzles as separate or linked bands.

An even more recent development involves injection of herbicides beneath the soil surface (subsurface lines) through tubes on the trailing edge of knife-type injectors. These injectors are set 3 to 3.5 inches apart, laterally, when injecting vernolate into sandy soils. The depth of application can be varied from about 1 inch to 6 inches below the surface of the soil.

In research at Tifton, Georgia, from 1963 to 1965, placement of vernolate in subsurface layers was consistently more effective than soil incorporation for nutsedge control in peanuts. The peanuts were planted 3 inches deep, and vernolate was usually applied 1.5 inches below the soil surface. Injury to peanuts with subsurface placement of vernolate over the peanut seed, however, was greater than with vernolate incorporated in the soil.

In 1966 studies, conducted on Tifton loamy sand and Greenville sandy clay loam, vernolate at 2 pounds per acre was appled as follows: (a) incorporated by disking or rototilling, (b) applied in snbsurface layers at either 2- or 4-inch depths, and (c) injected in lines beneath the surface of the soil as either preplanting, at planting, ground-cracking, or early postemergence treatments. Weather conditions were dry initially, then wet. Preplant injection in lines, or placement in subsurface layers, both at a depth of 4 inches, controlled yellow nutsedge with good peanut tolerance. Vernolate in layers 1½ inches below the soil surface severely injured the peanuts. Vernolate injected in lines 2 and 4 inches deep at the ground-cracking stage controlled nutsedge with little injury to peanuts. Line injections 2 inches deep, made seven days after peanuts emerged, produced excellent nutsedge control with excellent peanut

[1]Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, the Coastal Plain Experiment Station, Tifton, Georgia, and the Southwest Georgia Branch Experiment Station, Plains, Georgia.

tolerance. Vernolate incorporated in the soil did not control yellow nutsedge effectively.

These results show that injection of vernolate in lines beneath the soil surface is highly promising for nutsedge control and should be evaluated wherever nudsedge is a serious problem in peannts.

Effects of Row and Drill Spacing on Yield and Market Grade Factors of Peanuts

Aubrey C. Mixon
Agricultural Research Service
U. S. Department of Agriculture
in cooperation with
Alabama Agricultural Experiment Station
Auburn University
Auburn, Alabama

Peanut spacing tests at the Wiregrass Substation, Headland, Alabama from 1960 to 1964 involved Rnnner market-type varieties Early Runner and Virginia Bunch 67 all 5 years, and Virginia market-type Virginia Runner G26 the last 3 years.

Row width patterns on beds between tractor wheels set 72 inches apart included 4 rows 12 inches apart (18-inch average), 3 rows 24 inches apart (24-inch average), 3 rows 18 inches apart (24-inch average), and 2 rows 36 inches apart(36-inch average). Seed spacing in the drill averaged 3.5 inches in 1960 and 1961, and 4.5 inches in 1964. In 1962 and 1963 average plant drill spacings were 3, 4.5 and 6 inches.

Row width had no consistently statistically significant effect on pod yield, shelling percentage, average seed size, or proportion of seed riding a 15/64-inch screen. There was an interaction between row width and years for pod yield. No other significant interactions were found between row width and other treatment variables for attributes studied.

Different drill spacings averaged for 1962 and 1963 had no statistically significant effect on yield or market grade factors. There was a drill spacing and row width interaction for yield. This was largely accounted for by increased yields of Virginia Bunch 67 and Virginia G26 spaced 3 inches and 4½ inches in the drill, respectively for the 25-inch average row width when compared to wider drill spacings of each variety. However, this yield advantage for drill spacing was not apparent for other row widths. No other significant interactions were found between drill spacings and other treatment variables for attributes studied.

Under the conditions of these experiments, neither an advantage nor a disadvantage in yield or market grade resulted when these 3 Virginia-botanical-type peanuts were grown in rows closer than 36 inches apart. Average yields ranged from 1767 to 3170 pounds per acre, with an overall average near 2300 for Early Runner and Virginia Bunch 67, and near 2500 for Virginia Runner G26.

Aleurone Grains: The Flavor Houses of Roasted Peanuts

M. E. Mason, B. Johnson, P. Koehler and J. Newell
Department of Biochemistry
Oklahoma State University

Aleurone grains isolated from Argentine Spanish peanuts using density gradient procedures published by Diekert *et al* S. Food Sci. 27, 321 (1962) as modified by Mason and Waller (J. Agri. Food Chem., 12, 274 (1964) were roasted in glycerol by bringing the temperature to 120°C and holding with stirring until browning occurred. During this heating process an aroma typical of roasted peanuts developed.

Flavor components were removed from the roasted mixture by vacuum distillation and the condensate collected by cryogenic trapping in liquid nitrogen. Aleurone grains treated in this manner were essentially free of odor while the condensate possessed aroma like that from authentically roasted peanuts.

Since the collected condensate was mostly a water suspension of flavor components, it was necessary to eliminate the water before gas chromatograph analyses were performed. Repeated extractions were made with methylene chloride and the extracts were combined and the volume reduced under vacuum. Concentrated condensates from Argentine Spanish peanuts, dry roasted to a golden brown and ground to peanut butter, were obtained in the same manner as those of aleurone grains. Analyses of these condensates were performed on a prototype to the LKB-9000 combination gas chromatograph-mass spectrometer. The results showed that most of the same volatile components isolated from authentically roasted peanuts are also fonnd in artificially roasted aleurne grains. Structures of many of these compounds are known and are, at least in part, responsible for the typical aroma of roasted peanuts. Thus, a rare opportunity arises to stndy flavor formation in a compartmentolized system which is free of about 75 percent of the total solids of the peanuts. Since proteins are not involved in flavor formation during roasting (Mason and Waller, J. Agri. Food Chem., 12, 274 (1964) and since the aleurone is made up of proteins, only a small portion of material in the aleurones are actually flavor precursors.

Correlation Between Refractive Index and Iodine Number of Oil from Peanuts

F. L. Avera, E. L. Sexton, S. A. Watson and D. Melnick
Corn Products Company
Best Foods Division
Argo, Ill. and Bayonne, N. J.

Oil was cold pressed from representative samples of 677 shipments of raw peanuts from the 1962 crop which were received for the manufacturing of peanut butter. The oils were analyzed for iodine number and refractive index. Total oil was determined after roasting. The shipments included Medium Virginias, No. 1 runners and No. 1 Spanish from both the Southeast and Southwest. Range and mean iodine values were as follows: Virginias, 95.4-1000, 98.68; rnnners, 88.1-96.8, 91.41; S. W. Spanish, 90.2-102.8, 98.85; S. E. Spanish, 94.0-99.6, 95.92. Correlation of refractive index valnes against iodine values produced a coefficient of $r = + 0.899$.

Calculation of iodine values from refractive index data using the regression equation showed good agreement between actual and calculated values. Refractive index determination appears to have value as a tool for breeding peanuts for alteration of iodine value of the oil. The method is rapid and takes only a small sample, bnt a refractometer that reads to five decimals (precision type) gives best results. Total fat was not correlated with iodine value or refractive index.

Control of Stored-Peanut Insects by Atmospheric Gases

Hamilton Laudani and Arthur F. Press, Jr.
Stored-Product Insects Research Branch
Market Quality Research Division
Agricultural Research Service
U. S. Department of Agriculture
Savannah, Georgia

Research conducted at the Stored-Product Insects Research and Development Laboratory, Savannah, Georgia, has shown the use of controlled atmospheric gases to be very promising for protecting peanuts against insect damage during storage. The laboratory studies conducted included determining (1) the change in the concentration of the various gases that occurs in airtight storage by normal respiration of insect-free and infested peannts; (2) what combinations of oxygen, nitrogen, and carbon dioxide concentrations are lethal to the more important stored-product insects; (3) the exposure time required of these lethal mixtures to produce 80 to 100 percent mortality; and (4) the rate of flow of the gas or gases to produce and maintain a lethal atmosphere in a peanut storage.

Results of these studies have shown that through normal respiration of the stored commodity very little change in the concentration of the various gases occurred during airtight storage of noninfested shelled peanuts, but the oxygen concentration in the inshell peanuts decreased to less than 5 percent within 4 weeks. The oxygen concentration in both the infested shelled and inshell peanuts dropped to 3 percent or less in 2 weeks and during the same period the carbon dioxide concentration increased to about 10 percent in the inshell peanuts and to 7 percent in the shelled peanuts.

Any combination of oxygen, nitrogen, and carbon dioxide containing 2 percent oxygen or less was lethal to stored-product insects. The nitrogen concentration appeared to have little effect. However, if the oxygen concentration was increased to 7.5 percent and the carbon dioxide to 63 percent, 80 to 100 percent mortality was still obtained in 7 days. Similar mortality was obtained in 14 days even when the oxygen concentration was increased to 15 percent, provided the carbon dioxide concentration was increased to 36 percent.

About 2 weeks were required to kill stored-product insects in an atmosphere in which the oxygen concentration was gradnally reduced to less than 2 percent. However, if the oxygen concentration was reduced to less than 2 percent by purging with nitrogen or carbon dioxide, complete mortality was obtained within 2 days.

A flow rate of 200 cc/min. of carbon dioxide or nitrogen produced 100 percent mortality during 2 days' purging. Reducing the purging time to 24 hours reduced the mortality range to 57.5 to 82.5 percent. In addition, if the flow rate of carbon dioxide can be reduced to 50 cc/min., 80 to 100 percent mortality was obtained in 2 days.

Germination, microflora, and quality tests indicated that high concentrations of nitrogen and carbon dioxide had no deleterious effect on germination, aflaxtoxin production, and quality of stored peannts. In fact, quality of peanuts stored in nitrogen was somewhat higher than the quality of peanuts stored in air.

In summary, the use of nitrogen or carbon dioxide to purge tight storage facilities for controlling stored-product insects is promising.

Resistance of Peanuts to an Insect Complex

W. V. Campbell and D. A. Emery
N. C. State University
Raleigh, North Carolina

Tobacco thrips, potato leafhoppers, and southern corn rootworms are the principal insect pests of peanuts in North Carolina. A search for resistance among peanut varieties to this insect complex was initiated in 1960.

One peanut line exhibited a low level of resistance to thrips, a moderate resistance to the leafhopper, and high resistance to the southern corn rootworm for five years in varietal preference tests in the field.

Six peanut lines were classified as having a high resistance to the potato leafhopper for two years. Three other varieties have shown moderate resistance for three years.

Several peanut lines have shown a moderate to high level of resistance to the southern corn rootworm in field evaluations. The importance of plant resistance in an insect control program was ascertained.

Calcium and Peanut Pod Rot[1]

Kenneth H. Garren, Daniel L. Hallock, and W. E. Cooper
Research Plant Pathologist, Agricultural Research Service;
Associate Professor of Agronomy,
Virginia Polytechnic Institute;
and Associate Professor of Plant Pathology,
North Carolina State University

A few years ago we discovered in the Virginia-Carolina area an apparently newly important peanut disease. This is a disease in which many pods decay or disintegrate in the soil, greatly reducing yield. Earlier experiences led us to theorize that this pod rot is a new calcium-deficiency disease, developed under conditions in which a good deal of material containing calcium had been routinely applied to the soil.

Thus, if we followed our theory, we would be looking for proof of a calcium deficiency in plants growing in soils containing an apparent abundance of calcium. At a time when calcium sulfate in the form of agricultural gypsum or "landplaster" was routinely applied to peanuts at about 800 lb/A, we launched our study by applying 8,000 lb/A.

[1]Cooperative Investigations, Crops Research Division, Agricultural Research Service, U. S. Dept. of Agriculture, Virginia Polytechnic Institute, and North Carolina State University. Research conducted at Holland, Va. and Lewiston and Rocky Mount, N. C.

This we considered to be an absurd increase in the land-plaster rate, but one which might soon produce some helpful results.

From 1961 to 1963 we compared percentages of decayed pods at harvest, and harvested yield of plots receiving 8,000 lb/A landplaster with the pod rot and yield of plots receiving only 800 lb/A landplaster. In every instance a percentage of pods significantly lower than the 8000 lb/A treatment was found rotted at harvest in the 8,000 lb/A landplaster treatment. In most instances the harvested yield was significantly higher in the 8,000 lb/A treatment than in the 800 lb/A treatment.

We also tried several other control measures on this pod breakdown, but in the end high calcium was the only lead that seemed worthy of further study.

Our studies during the past 2 years might be called "refining studies." In these continuing studies we seek answers to questions such as the following:

Is the calcium or the sulfate of landplaster the active ingredient when increased landplaster decreases pod rot and increases yield? Preliminary results indicate that the active ingredient is calcium. In a 1965 field experiment an increase in pod breakdown occurred in plots receiving magnesium and potassium sulfates, when compared with plots receiving no sulfate. Plots receiving calcium sulfate had significantly less pod rot than any of the other treatments.

How does calcium bring about a reduction in pod decay? We cannot yet answer this question. However, results from 1964 showed much more calcium in cells of peanut pods which had received 1,500 or 3,000 lb/A of landplaster than in the cells of pods receiving no landplaster. In a number of instances in studies of other plant diseases calcium cations have been found to inhibit or stop action of enzyme systems by which the causal organism breaks down and destroys tissues of living plants.

Will a similar increase of landplaster prove beneficial in other localities? Some 1965 results from Holland, Va., Rocky Mount, N .C., and Lewiston, N. C., suggest that the answer is "yes," but more research is needed to confirm these results.

Is there a pod rot potential for a given field? If so, does the pod rot potential influence the response to landplaster? In 1965 studies where no landplaster was applied, considerable variation was found from field to field in the percentages of pods which decayed. This indicates that pod-rotting organisms are more active in some fields than in other fields. These pod rot prone fields or what we would call "fields with a high pod rot potential" respond readily to an increase in landplaster by a reduction in pod rot.

This relationship seems to hold for yield also. Fields which yielded 36 to 39 hundred pounds per acre with no landplaster, showed slight yield response to landplaster. Fields which yielded in the 22-25 hundred pound range with no landplaster, showed a marked yield response to landplaster.

Are increased landplaster application rates of the 10-fold magnitude necessary for pod rot control? The answer appears to be "no." However, we do not know yet whether the best rate is a 2-fold, 3-fold, or 4-fold increase. Possibly the best rate of application will be determined by the pod rot potential of the field.

What will be the effect of repeated applications of high levels of soluble calcium on soil fertility, especially in regard to availability of other minor elements? Before we can answer this question we will have to study the problem through several full cycles of one or more rotations that include peanuts. In such studies, cumulative effects on soil fertility would be evaluated by relating performance of all crops in the rotation and chemical analyses of soil and plant tissue to landplaster levels applied to peanuts.

There are some long-range implications also. If we are correct in speculating that our present pod-rotting organisms developed or evolved in fields in which landplaster was applied at approximately 500 lbs. per acre, then we should expect newer pod-rotting organisms to evolve in fields in which landplaster is applied at 2,000 lbs. per acre. Rather than look forward to increasing the application rate of landplaster every 10 years or so, we propose to look into the matter of pod-rot potentials of fields. We shall seek a control method based in part on the nature of the pod-rot potential, a method which does not rely entirely on action of calcium.

Symptoms and Yield Reduction Caused by Peanut Mottle Virus

C. W. Kuhn
Georgia Experiment Station
Experiment, Georgia

A leaf mottling disease was observed in Georgia peanut fields in 1961. Although it is a mild appearing disease, over 90 percent of the field plants tested were diseased at harvest time. After transmission studies established that the causal agent was a virus, detailed studies were conducted to describe the disease, to determine characteristics of the virus, and to determine the effect on yield. The causal agent was named peanut mottle virus (PMV).

In addition to leaf mottling, two other distinctive symptom types were observed under controlled conditions: (1) upward curling of leaflets, and (2) depression of interveinal tissue. All studies of the virus and disease were aided when bean cultivar Topcrop proved to be an assay host for the virus. Sixteen species of Leguminosae were susceptible to the virus, and no non-leguminaceous host has been infected to date.

Two susceptible species, *Cassia tora* and *Trifolium incarnatum*, were found frequently in or near peanut fields, but their importance in the disease cycle has not been established. The virus was isolated from both mottled and symptomless plants in four areas of Georgia, and from diseased plants sent from Virginia.

It was determined that the virus was most infective in phosphate buffer containing an antioxidant. *Canavalia ensiformis* and *Pisum sativum* may be better experimental hosts than peanut since the virus concentration is higher in them. *In vitro* studies of physical properties indicated that the virus was relatively unstable, but that it could be manipulated in laboratory experiments.

One reason that virus diseases of peanuts have been considered unimportant is their mild effect on the foliage. This effect for PMV was confirmed in greenhouse tests where it was established that the dry weight of shoots was similar for both diseased and healthy plants. However, the root system (dry weight) was reduced 17 percent, and pod and seed weight was reduced 20-32 percent. Furthermore, pod and seed discoloration was more prevalent on diseased plants than on healthy ones. The virus was transmitted through 2 percent of the seed from diseased peanuts.

Status of the Peanut Leafspot Control Problem

Lytton W. Boyle
Plant Pathologist
Georgia Experiment Station
Experiment, Georgia

The ideal control in a problem such as the leafspots of peanuts is in the development and maintenance of immune or highly resistant varieties. Until such time as varieties with these qualities are combined in our commercial seed stocks the possibilities for improvement in control with fungicides should not be neglected.

A good number of what appear to be promising fungicidal formulations are available but critical evaluation of these is not possible without improvement in both our equipment and schedule of application.

Applications made according to a schedule based on an arbitrary number of calendar days are too often ineffective and thus costly. In cooperative studies with the Weather Bureau Agricultural Service it has been determined that a correlation between the number of hours the relative humidity stays at or above 95 percent and the minimum temperature obtained during the period of high humidity gives a good index of how rapidly the number of infections is increasing. So far these studies have been in very limited areas. Present studies are to determine

if such observations can be applied to wider areas and a program of radio warnings be developed for broadcast over small local stations. This more realistic basis for our schedule of applications would be more effective and less costly.

Calonectria Root, Peg, and Pod Rot of Peanut

D. K. Bell and E. K. Sobers
Assistant Plant Pathologists
Department of Plant Pathology
Georgia Coastal Plain Experiment Station
Tifton, Georgia

In August 1965, an apparently unreported disease of peanuts (*Arachis hypogaea* L.) was observed in Southwest Georgia. The disease occurred in fields of a heavy Greenville clay loam with a hardpan below the furrow slice following an extremely wet June and July. Wilted and chlorotic plants were found in small, scattered spots in some fields, and in others covered several acres. Wilted leaves were blighted along the margins and at the tips. Chlorosis and wilting of the tiller foliage was usually less extensive than that of the erect primary branches. Extensive blackened necrosis was evident on pegs, pods, and lateral roots, with tap roots frequently reduced to blackened and fragmented stubs. The necrosis usually terminated at the ground line.

Red to orange perithecia were found on many decayed stems. After examination of asci and ascospores contained within these perithecia, the fungus was identified as belonging to the genus *Calonectria*. Cultures from single ascospores and isolations from necrotic roots, pegs, and pods yielded typical colonies of a *Cylindrocladium*. A review of available literature revealed no previous account of a species of *Calonectria* or *Cylindrocladium* associated with peanuts.

Pathogenicity tests were conducted in the greenhouse on all parts of 1-month-old cv. Early Runner peanut plants and on foliage of 2-month-old eucalyptus (*E. camadulensis* Dehnhardt, *E. grandis* Smith, *E. robusta* Smith, *E. rudis* Smith, and *tereticornis* Smith) and crotalaria (*Crotalaria spectabilis* Roth) seedlings. Inoculum consisted of cultures grown on potato-dextrose-agar and blenderized in water. Leaves of inoculated peanut plants exhibited circular brown lesions 0.5-1 mm in diameter surrounded by chlorotic halos up to 2 mm in diameter by 4-6 days after inoculation. The roots, pegs, and pods of all peanut plants grown for 1 month in soil infested with the pathogen became diseased. On two sets of 20 inoculated plants, the length of tap roots and central leaders was reduced by an average of 17 and 20 percent, respectively; and peg and pod production was 25 percent less than that of the control plants. Irregularly circular, reddish-purple lesions measuring 0.5-3 mm in diameter were apparent on the leaves of all species of *Eucalyptus* 3-5 days after inoculation. Dark brown, circular to subcircular lesions measuring 1-8 mm in diameter developed on crotalaria leaves during the same period.

Perithecia of the fungus are orange to red, subglobose to oval or obovate, and are 320-465 μ high and 290-350 μ wide. Asci are hyaline, clavate, long-stalked, thin-walled, contain eight ascospores, and measure 95-138 x 13-19 μ. Ascopores are hyaline, granular, fusoid to falcate, one to three septate, slightly constricted at the median septum, and measure 34-58 x 6.3-7.8 μ

The imperfect stage is characterized by dichotomously and trichotomously branched conidiophores arising laterally from a main central axis that terminates in a hyaline, globose swelling measuring 6-13 μ in diameter. Conidia are hyaline, granular, cylindric, mostly one to three septate, and measure 58-107 x 4.6-7 μ.

The perfect stage of the causal fungus is tentatively identified as *Calonectria theae* Loos var. *crotalariae* Loos, and the imperfect stage as a species of *Cylindrocladium*, which will be described in detail at a later date.

Effect of Environment on Aflatoxin Production by *Aspergillus flavus* in Sterile Peanuts[1]

U. L. Diener and N. D. Davis

The limiting environmental conditions for aflatoxin production by *Aspergillus flavus* was investigated with heat-treated peanuts stored after inoculation in eight 10 cu. ft. environmental cabinets adjusted to temperatures of 5-55 ± ½ C and relative humidities of 55-99 ± 1 percent. Peanuts were sampled after 7 and 21 days of incubation and the kernel moisture, aflatoxin, and free fatty acid content were determined. Relative humidity was more closely correlated to aflatoxin content than kernel moisture content. *A. flavus* grew well at temperatures of 14-43 C at 97-99 percent relative humidity, and at relative humidities of 86-99 percent at 30 C. Aflatoxin formed in peanut kernels at 14 and 40 C, but not at 12 and 43 C at high humidities. Aflatoxin was produced at 86-99 percent relative humidity, but not at 85 percent relative humidity at 30 C. There

[1]Contribution from the Botany and Plant Pathology Department, Auburn University Agricultural Experiment Station, Auburn, Alabama. These investigations were supported in part by Public Health Service Research Grant EF 00590-02 from the Division of Environmental Engineering and Food Protection, and in part by other investigations supported by U. S. Department of Agriculture Research Contract 12-14-100-7754(72), supervised by the Southern Utilization Research and Development Division, Agricultural Research Service. Published with the approval of the Director of the Auburn University Agricultural Experiment Station.

appeared to be little difference between aflatoxin levels of sound mature, broken mature, and immature kernels, and kernels from peannts with intact shells.

Aflatoxin Production by Aspergillus flavus in a Semisynthetic Medium[1]

N. D. Davis, U. L. Diener, and D. W. Eldridge

Cultural conditions for production of high levels of aflatoxin and the toxin-producing ability of *Aspergillus flavus* isolates were investigated. Liter flasks containing 100 ml of nutrient solution were inoculated with spores and incubated 6 days at 25 C as stationary cultnres. Aflatoxin assays were by tbin-layer chromatography procedures. Maximal levels of aflatoxins B_1 and G_1 were produced in a liquid medium (YES) consisting of 2 percent Difco yeast extract and 20 percent sucrose in demineralized water. *A. flavus* ATCC 15548 produced the largest amount of total aflatoxins. Three isolates produced bigh levels, whereas another three produced smaller amounts. One isolate produced predominately aflatoxin B_1, while the other six isolates produced approximately equal amounts of aflatoxin B_1 and G_1. The YES medium was especially suitable for screening *A. flavus* isolates for toxin producing ability and for the production of aflatoxin in stationary cnltures.

[1]See footnote, previous abstract.

Aflatoxin Production by Aspergillus flavus in Submerged Culture[1]

A. W. Hayes, N. D. Davis, and U. L. Diener

The effect of aeration on aflatoxin production in submerged culture by three isolates of *Aspergillus flavus* in a yeast extract-sucrose (YES) medium, previously found to be optimum for toxin production in stationary culture, was investigated. Ten liters of a 2 percent Difco yeast extract-10 percent sucrose medium were inoculated witb a spore suspension and incubated in 14-liter fermentors for 5- and 9-day periods at 30 C with constant stirring (100 rpm). Aeration was at the rates of 3,000, 6,000, 9,000 and 12,000 ml/min. Daily aflatoxin analyses of 10-ml aliquots of clarified fermentation medium partitioned with chloroform were developed on thin-layer chromatograms. Aflatoxin production increased with time at all aeration rates throughout both the 5- and 9-day experiments.

[1]See footnote, previous abstract.

However, considerably more aflatoxins were produced at the higher aeration rates than at the lower rates. Maximal aflatoxins were produced in both time periods at 9,000 ml/min. Highest yields of aflatoxin were obtained by the 8th day at 9,000 cc/min with *A. flavus* ATCC 15517. The other two isolates of *A. flavus* produced much less aflatoxin than *A. flavus* ATCC 15517 under aeration conditions investigated.

Effect of Temperature on Aflatoxin Production by Isolates of Aspergillus flavus and A. parasiticus[1]

U. L. Diener and N. D. Davis

Aspergillus flavus isolated from peanuts from Alabama, Florida, Georgia, New Mexico, North Carolina, Texas, and Virginia produced aflatoxin when cultured on peanuts and in nutrient solution. Similar results were obtained with *A. flavus* isolated from corn, oats, wheat, rice and soybeans. The isolate of *A. flavus* that produced only aflatoxin B_1 had an optimal temperature near 25 C. The optimal temperature range for production of aflatoxin B_1 and G_1 by *A. parasiticus* was 25 to 30 C. Temperature had a direct effect on the proportion of aflatoxin B_1 to G_1 produced by *A. parasiticus* on both natnral and nutrient media.

[1]See footnote, previous abstract.

Relationship Between Aspergillus Flavus Growth, Fat Acidity and Aflatoxin Content in Peanuts[2]

H. E. Pattee and Sandra L. Sessoms

Fat acidity determinations on peanuts made by a rapid method developed by Baker and co-workers (Cereal Chem. 34:226-233; 1957) for grains and by the official A.O.A.C. method were compared. The samples analyzed by botb methods ranged in fat acidity values from 17 to 29 mg KOH per 100 g kernels. The mean difference was 0.75 and the standard deviation of the mean difference was 1.7. The rapid method was thus accepted as satisfactory for determining fat acidity in peanut kernels. The advantage of the rapid method is that one sample may be analyzed in approximately 10 minutes as compared to 16.5 hrs by the official A.O.A.C. method.

The influence of fungal growth, under standardized conditions, on

[2]Contribution from the Departments of Botany and Biological and Agricultural Engineering, North Carolina Agricultural Experiment Station, Raleigh, N. C., in cooperation with the U. S. Department of Agriculture, ARS, MQRD.

fat acidity in large-seeded Virginia-type peanuts inoculated with *Aspergillus flavus* and relationships between fat acidity and aflatoxin, a toxic metabolite produced by *A. flavus* were studied using the rapid method. Fat acidity increased quadratically and was highly correlated with visible fungal growth. Aflatoxin production lagged behind fat-acidity increase; fat acidity reached 60 mg KOH per 100 g kernels before aflatoxin became detectable (Table I.).

Table 1. Relationship between fat acidity and aflatoxin of inoculated peanut kernels.

Acidity Range	Range of Mold Score	Number of Observations	% Samples Containing Aflatoxin	Aflatoxin Range	Average Aflatoxin Level
				ug/kg Kernels	
16-30	0-1	18	0	0	0
31-60	1-2	4	0	0	0
61-90	1-3	7	71	0-71	18
91-120	2-3	10	90	0-1200	238
121-150	2-4	10	100	6-900	341
151-190	2-4	10	100	6-900	312
191-300	4	8	100	72-900	515

This relationship suggests the use of a rapid method of determining fat acidity for screening peanut samples for the possible presence of aflatoxin.

Windrow Orientation and Harvesting Damage to Peanuts[1]

James W. Dickens and Jogendra S. Khalsa
Agricultural Engineer
Market Quality Research Division
Agricultural Research Service
United States Department of Agriculture
North Carolina State University
Raleigh, North Carolina
and Research Assistant
Colorado State University
Fort Collins, Colorado
formerly at N.C. State University

Windrow harvesting is the method most widely used for peanuts in the United States. Problems associated with this method are the risk of field losses and mold damage caused by adverse weather while the peanuts are in the windrow, mechanical damage to peanuts when harvested with cylinder-type combines, and mold damage during subsequent bulk curing. The capacity of *Aspergillus flavus* and some other molds to produce toxic materials in peanuts stresses the need to reduce mold growth during the harvesting and curing of peanuts.

The purpose of this study was to determine the effects of plant orientation on the drying of peanuts in windrows and the effects of window orientation and moisture content at time of combining on the following quality factors: (a) loose shelled kernels and pod damage caused by combining (b) milling quality, (c) germination of seed, and (d) aflatoxin contamination of peanuts, which had been inoculated with *Aspergillus flavus*, when combined and after bulk curing.

Moisture content at time of combining had the following effects on peanut quality. (a) Loose shelled kernels and pod damage decreased with an increase in moisture content except that for inverted windrows the amount of pod damage appeared to increase for moisture contents above 35 percent. (b) Milling quality of combined peanuts was best at intermediate moisture contents (30 to 40 percent), while the milling quality of hand-picked peanuts was inversely proportional to moisture content. (c) Percent seed germination decreased with an increase in moisture content. No relationship between moisture content and aflatoxin contamination was determined.

Peanuts in inverted windrows dried to 25 percent moisture in half the

[1]Contribution from the North Carolina Agricultural Experiment Station and the U. S. Department of Agriculture, Agricultural Research Service, cooperating.

time required for peanuts in random windrows. Although results are not conclusive, peanuts combined from inverted windrows appeared to receive less mechanical damage and to be of better quality in the following respects: (a) fewer loose shelled kernels and less pod damage, (b) better seed germination, (c) better milling quality, and (d) less risk of aflatoxin contamination when toxin-producing molds are present.

Apical kernels in peanut pods were more subject to mechanical damage during combining than basal kernels. In these peanuts, which had been inoculated with *Aspergillus flavus*, shelled kernels were more often contaminated with aflatoxin during bulk curing than were peannts in sound pods.

Report of PIWG Committee on Methods for the Determination of Quality Factors in Peanuts

E. L. Sexton, D. A. Emery, Astor Perry, and Calvin Golumbic

At the 1965 Peanut Improvement Working Group meeting held in Washington, D.C., the Chairman appointed a committee to (a) determine the factors related to peanut quality for which various segments of the peanut industry felt objective methods of measnrement should be developed; and (b) survey the methods currently available to measure these factors. This committee polled individuals representing various segments of the peanut industry whom they felt would have information of this kind. Findings which constitute their report are summarized in Table 1.

Several general comments were widespread throughout the reports received by the committee members: (a) a universal recognition of the vital need for providing all segments of the peanut industry with generally acceptable and standardized methods for the determination of specific peanut quality factors; (b) the feeling of collective embarrassment at the scarcity of such objective methods; and (c) a hope that the Peanut Improvement Working Group can initiate an effective program to provide such methods.

In addition to comments on methods applicable to peanuts (which cover the limited objectives of this committee) were excellent suggestions as to the need for objective methods which could be applied to the peanut plant as a whole, such as pod retention under physiological stress, resistance to growth cracks, resistance to major diseases, resistance to insects, prolificasy, stem thickness and woodiness and resistance of seedlings to mold growth.

If a committee on methods for the determination of quality factors in peanuts is appointed for the coming year, direction should be given to the committee along the following lines: (a) Are there any major quality factors which the 1965 report did not mention? (b) Which of the quality factors (perhaps a maximum of five) should be singled out for maximum attention in developing or improving methods during 1966; and (c) How can this work (perhaps by using small groups, each working on a single method) be more effectively implemented?

Table 1. Peanut quality factors for which objective, standardized methods of measurement should be derived.

Quality Factor	Type of peanut[a]	Available Methods Indicated[b]
1. Maturity	S	Spectrophotometric on peanuts, (a) spectrophotometric evaluation of expressed oil (b) sugar content, unsaturation of the oil.
2. Resistance to mold growth	IS or S	None
3. Color	IS or S	Use of color "chips" similar to those used by the USDA for peanut butter.
4. Shape of peanut	S	Use of slotted screens with relatively small samples.
5. Density	Raw or Roasted	Beckman air pynometer, count per pound, sand displacement, fluctuation
6. Concealed damage	S	Federal - State Grading Procedure (c)
7. Milling Quality	Raw or Roasted	Small-scale sheller (d)
8. Blanchability	IS	Small-scale blancher, hand blanching (e)
9. Kernel Hardness	S	Penetrometer (f)
10. Texture of Keruel	S	None
11. Tendency for radicle breakage	S	None
12. Pod thickness	IS	Micrometer or microscope measurement
13. Pod fragility	IS	Impact tester
14. Mold Count	S	Direct count (g)
15. Aflatoxin Content	S	Chromatographic method (h)
16. Infestation	IS	Direct Count (i)
17. Skin Slippage Tendency	S	None
18. Flavor	Raw or Roasted	Flavor panel evaluation of ground, roasted peanuts (j), or roasted peanuts (k)
19. Chemical Constituents	S	Moisture - Oven (l), Moisture meter (m), distillation (n)
	Raw or Roasted	Oil - Total (o), iodine value (p), fatty acid content (q), fatty acid composition (r), rancidity potential (s), Tocopherol content (t) Protein - Total (u) Vitamin (v)

[a]S = Shelled peanut; IS = Peanut in the shell.
[b]Letters a-v refer to references following Table I.

References

(a) Kramer, H. A., Gates, J. E. Demeree, K. D., and Sidwell, A. P., 1963. Spectrophotometric investigations on peanuts with particular reference to extimation of maturity. Food Technology 17(7): 90-92.

(b) Determine the optical density of cold pressed oil from raw peanuts at 350, 450, and 520 mμ. wavelengths in comparison with distilled water. The optical density of 520 mμ. is subtracted from the optical density at 450 mμ. and 380 mμ. The corrected optical density at 450 mμ. is further modified by the subtraction of one-half the corrected optical density at 380 mμ. The procedure provides a corrected net optical density for the oil at 450 mμ. which is corrected for the effects of haze. Values of 0.1 or greater for the corrected optical density at 450 mμ. are considered as indicators of undesirable average immaturity.

(e) Hand blanch ten roasted peanuts by gently rubbing between the fingers. Arrange these peanuts in piles representing approximately 0%, 25%, 50%, 75% and 100% blanching. Multiply the number of peanuts in each pile by the percent of blanching and these figures and divide 10 to obtain an index of blanchability.

(f) "Penetrometer Characteristics of Peanut Kernels", Richard C. Pluck, M.S. Thesis in Agricultural Engineering, North Carolina State University 1962.

(g) Method as devised by the Canadian Food and Drug Directorate.

(h) Thin layer chromatographic methods developed by the U. S. Food and Drug Administration and published in the Journal of the Association of Official Agriculture Chemists during 1965.

(i) Screen samples of peanuts over a large size hardware cloth screen of approximately ¼ inch square openings. Examine the material falling through the screen for signs of live and dead infestation.

(j) Grind roasted peanuts and present uniform samples to an expert flavor panel, utilizing the principles as described in "Principles of Sensory Evaluation of Foods" by M. A. Amerine, R. M. Pangborn and E. B. Roessler, Academic Press, 1965.

(k) Spread out a sample of roasted peanuts and using an "X" pattern of sampling, remove 20 peanuts from the sample. Remove the skin and germ from each peanut. Taste each peanut and characterize it as bad off-flavor, low level off-flavor, low peanut flavor, or good peanut flavor. Record the percentage of peanuts falling into each category.

(l) A.O.C.S. Official Method Ab2-49***.

(m) Federal-State Inspection Procedure.

(n) No reference provided.

(o) A.O.C.S. Official Method Ab-3-49.

(p) A.O.C.S. Official Method Cdl-25.

(q) A.O.C.S. Official Method Ab5-49.

(r) A.O.C.S. Official Method Cel-62.

(s) No reference provided.

(t) Bunnell, R. H., J. Keating, A. Quaresimso and G. K. Parman, Alpha-tocopherol control of foods, American Journal of Clinical Nutrition *17* 1-10 (1965).

(u) A.O.C.S. Official Method Ab4-50.

(v) "Official Methods of Analysis of the Association of Official Agricultural Chemists", Tenth Edition (1965), pp. 752-86.

***"Official and Tentative Methods of the American Oil Chemists' Society". 1965.

List of Persons Who Attended The Fourth National Peanut Research Conference

Morris W. Alexander
Holland, Va.

Norman Alexander
Route 2
Blakely, Ga.

S. A. Alfiere, Jr.
Florida Department of Agricultnre
P. O. Box 13777
Gainesville, Fla.

A. H. Allison
Tidewater Research Station
Holland, Va.

H. E. Anderson
Box 2210
Goldkist Peanuts
Atlanta, Ga.

Joe Anderson
2554 Sherbrooke Dr., N. E.
Atlanta, Ga.

Phil Arey
Box 37
Montverde, Fla.

Andrew Avery
Box 492
Bainbridge, Ga.

W. K. Bailey
Plant Indnstry Station
Beltsville, Maryland

Donald J. Banks
Agronomy Department
Oklahoma State University
Stillwater, Okla.

Rudy Barden
4106 Harvey Road
Raleigh, N. C.

Durham K. Bell
Coastal Plain Experiment Station
Tifton, Ga.

E. S. Bell
Seitz Hall, VPI
Blacksburg, Va.

David A. Benson
1229 Baldwin Dr.
Orlando, Fla.

Jim Benson
712 Powell Drive
N. C. State University
Raleigh, N. C.

Roy W. Blanton
Prattville, Ala.

J. Knapp Boddiford
Milhaven Company
Milhaven, Ga.

T. E. Boswell
Plant Disease Experiment, Route 3
Texas Agricultural Experiment Station
College Station, Tex.

Lytton W. Boyle
Georgia Experiment Station
Experiment, Ga.

Lewis L. Branscomb
Goldkist Peannt Growers
Graceville, Fla.

Jere A. Brittain
Department Plant Pathology
United States Rubber
Blacksburg, Va.

C. A. Brogden
Box 206
Headland, Va.

P. C. Bryant
308 Halifax Street
Williamston, N. C.

Richard H. Bryant
P. O. Box 46
Gatesville, N. C.

J. L. Butler
Coastal Plain Experiment Station
Tifton, Ga.

W. V. Campbell
Box 5215, North Carolina State University
Raleigh, N. C.

Broadus Carmichael
733 Forest Trail N. W.
Atlanta, Ga.

D. M. Carter
507 Boxwood Ct.
Suffolk, Va.

R. L. Carter
Coastal Plain Experiment Station
Tifton, Ga.

W. A. Carver
Goldkist Peanut Growers
Graceville, Fla.

Sam R. Cecil
Georgia Experiment Station
Experiment, Ga.

Jim Chandler
658 Westover Road
Columbia, S. C.

F. C. Clapp
Corn Products Company
Eufaula, Ala.

Tom Cleveland
811 Wesley Drive
Montgomery, Ala.

W. G. Collins
Sasser, Ga.

W. G. Conway
P. O. Box 921
San Antonio, Texas

T. E. Corley
Auburn University
Auburn, Ala.

Fred Cox
Soil Science Department
North Carolina State University
Raleigh, N. C.

Johnny L. Crawford
Box 948
Tifton, Ga.

Fred Crosby
Georgia Experiment Station
Experiment, Ga.

C. M. Cuishank
Stevens Industries
Dawson, Ga.

E. R. Culbertson
Dixie Limestone Company
Albany, Ga.

T. W. Culp
Tidewater Research Station
Holland, Va.

Ben P. Curtis
P. O. Box 599
Fairfield, Ala.

Frank G. Dollear
Route 2, Box 204
Pearl River, La.

R. G. Daniel
G. F. A.
Metter, Ga.

James I. Davidson, Jr.
109 South Monroe Street
Department of Agriculture
Albany, Ga.

H. W. Davis
U. S. Gypsum Company
101 South Wacker Drive
Chicago, Ill.

Norman Davis
Botany Department
Auburn Uuiversity
Auburn, Ala.

James W. Dickens
P. O. Box 5906
N. C. State University
Raleigh, N. C.

Urban L. Diener
Plant Pathology Department
Auburn University
Auburn, Ala.

G. B. Duke
USDA
Holland, Va.

Lester Dykes
Banks, Ala.

C. T. Dwarakanath
P. B. No. 19687
New Orleans, La.

David W. Eldridge
Botany Department
Auburn University
Auburn, Ala.

D. A. Emery
Crop Science Department
North Carolina State University
Raleigh, N. C.

B. L. Flippen
Box 75
Emporia, Va.

Melton Flowers
Troy, Ala.

Homer K. Gardner, Sr.
1128 Elmaer Avenue
Metairie, La.

Kenneth H. Garren
Plant Pathology Department
Tidewater Research Station
Holland, Va.

H. H. Geiger
Headland, Ala.

J. B. Gillam, Jr.
Gillam Brothers Peanut Company
Windsor, N. C.

John W. Glover
North Carolina State University
Raleigh, N. C.

F. E. Grace, Jr.
P. O. Box 362
Albany, Ga.

James S. Gray
3311 Archdale Drive
Charlotte, N. C.

John W. Greene
P. O. Box 582
Albany, Ga.

C. L. Gupton
216 Compton Road
Raleigh, N. C.

D. L. Hallock
V. P. I.
Holland, Va.

Ray O. Hammons
Peanut Investigations - USDA
Tifton, Ga.

Richard T. Hanlin
Georgia Experiment Station
Experiment, Ga.

A. B. Harliss
Albemarle Peanut Company
Edenton, N. C.

Brodie H. Harrell
Box 381
Jackson, N. C.

George F. Hartnett
221 North LaSalle Street
National Peanut Council
Chicago, Ill.

Mrs. Martha Harwood
P. O. Box 362
Albany, Ga.

Ellis W. Hauser
Route 3
Tifton, Ga.

Bill Hay
Goldkist Peanut Growers
Graceville, Fla.

Wallace Hayes
Auburn University
Auburn, Alabama

J. R. Henderson
University of Florida
Gainesville, Fla.

Rodney O. Hexem
School of Agriculture
Arkansas State College
State College, Ark.

Raymond D. Hicks
Route 1
Portageville, Mo.

O. D. Hill
Sasser Seed Sheller
Sasser, Georgia

C. E. Holaday
P. O. Box 312
Albany, Ga.

K. T. Holley
Experiment, Ga.

W. A. Horton
Stevens Industries
Dawsou, Georgia

Jack Howell
Farmers Gin & Warehouse
Blakely, Ga.

Robert W. Howell
Plant Industry Station
Beltsville, Md.

Reed S. Hutchison
109 S. Monroe Street
Albany, Ga.

Bolton Wm. Jones, Jr.
238-B Buck Jones Road
Raleigh, N. C.

Herbert L. Jones
P. O. Box 86
Agricultural Extension Agent
Smithfield, Va.

Lewis Knox
Alabama Peanut Products
Luverne, Ala.

N. P. J. Kriek
P. O. Box 211
Pretoria
Republic of South Africa

C. W. Kuhn
Georgia Experiment Station
Experiment, Ga.

A. J. Lambert
Seitz Hall V. P. I.
Blacksburg, Va.

H. Laudani
3414 Edwin Avenue
Stored Product Insect Lab
Savannah, Ga.

S. Womack Lee
Peanut Growers Co-op
Franklin, Va.

Wayne E. Livingston
3327 W. 48th Place
Chicago, Ill.

Edward L. Locks
Prattville, Ala.

W. C. Louis
3098 Piedmont Road N. E.
Atlanta, Ga.

Candelario Martinez, Jr.
P. O. Box 23156
San Antonio, Tex.

Michael E. Masou
Department of Biochemistry
Oklahoma State University
Stillwater, Okla.

W. F. Massey
2546 Shallowford Road N. E.
Number 154
Atlanta, Ga.

Ralph S. Matlock
Agronomy Department
Oklahoma State University
Stillwater, Okla.

J. A. Mauldin
Corn Products Company
Camilla, Ga.

George McClus
H. B. Reese Candy Company
Hershey, Penn.

Bill Mills
Box 407
Albany, Ga.

Norman A. Minton
USDA
Tifton, Ga.

Aubrey C. Mixon
Agronomy & Soils - USDA
Auhurn University
Auburn, Ala.

Emil A. Moherek
Chevron Chem. Co.
Box 160
Ocoee, Florida

Gurnia M. Moore
Box 220
Montgomery, Ala.

Loy W. Morgan
Coastal Plain Experiment Station
Tifton, Ga.

G. W. Morrow, Jr.
Durant Cotton Oil & Peanut
Corporation
Durant, Okla.

Paul A. Mott
Comar Hall
Auburn University
Auburn, Ala.

R. S. Mullin
University of Florida
Gaiuesville, Fla.

A. J. Norden
Agronomy Department, McCarthy
Hall
University of Florida
Gainesville, Fla.

John B. O'Neil
5107 Azeele Street
Tampa, Fla.

Wilbur A. Parker
99 Avenue "A"
Bayonne, N. J.

Sammie B. Parkman
Foundations Seeds, Inc.
Athens, Ga.

Roy E. Parrish
Box 18851
Lenox Station
Atlanta, Ga.

Harold E. Pattee
P. O. Box 5906
North Carolina State University
Raleigh, N. C.

John R. Paulling
FES-USDA
Washington, D. C.

Grady E. Pearman
Coastal Plain Experiment Station
Tifton, Ga.

Jack L. Pearson
P. O. Box 312
Albany, Ga.

Astor Perry
460 Williams Hall
North Carolina State University
Raleigh, N. C.

Richard A. Phelps
Box 2538
Houston, Tex.

Larry Prince
Box 844
Tifton, Ga.

Sydney C. Reagan
3840 Greenbrier
Dallas, Tex.

L. M. Redlinger
Coastal Plain Experiment Station
Tifton, Ga.

C. E. Rice
Agricultural Engineering
Department
University of Georgia
Athens, Ga.

Jean Rice
P. O. Box 2210
Dixie Co-op News
Atlanta, Ga.

J. L. Robertson
Prattville, Ala.

R. O. Rogers
ARS - USDA
Washington, D. C.

Don W. Sands
P. O. Box 2210
Atlanta, Ga.

Max C. Sconyers
934 Pamlicor Drive
Cary, N. C.

Ed Sexton
99 Avenue "A"
Bayonne, N. J.

John L. Shepherd, Jr.
Coastal Plain Experiment Station
Tifton, Ga.

A. J. Singletary
Blakely Peanut Company
Blakely, Ga.

Bill Smart
Georgia Experiment Station
Experiment, Ga.

J. R. Stansell
Coastal Plain Experiment Station
Tifton, Ga.

C. M. Stokes
Auburn University
Auburn, Ala.

Miss Pat Stubbs
P. O. Box 471
Columbus, Ga.

Joe S. Sugg
P. O. Box 409
Rocky Mount, N. C.

Gene A. Sullivan
Box 248
Elizabethtown, N. C.

J. C. Taft
905 Harrison Street
Nashville, Tenn.

W. Kent Taylor
155 Sherwood Drive
Athens, Ga.

Malcolm Thomas
Texas A & M University
College Station, Tex.

S. S. Thompson
P. O. Box 48
Tifton, Ga.

Peter Tiemstra
6543 Pontiac Drive
LaGrange, Ill.

Leland Tripp
Ronte 4
Stillwater, Okla.

J. L. Troutman
Box 430
Chatbam, Va.

Milton Walker
Coastal Plain Experiment Station
Tifton, Ga.

C. H. Warnken
P. O. Box 23156
San Antonio, Tex.

S. A. Watson
Box 345
Argo, Ill.

Tom Webb
P. O. Box 14006
Gainesville, Fla.

J. C. Wells
North Carolina State University
Raleigh, N. C.

H. C. Wheeler
Stevens Indnstries
Dawson, Ga.

C. Leroy Whitley
3098 Piedmont Road
Atlanta, Ga.

DeVoe H. Willard
400 Bender Building
Washington, D. C.

E. Jay Williams
Coastal Plain Experiment Station
Tifton, Ga.

Coyt T. Wilson
V. P. I.
Blacksburg, Va.

Herbert Womack
P. O. Box 948
Tifton, Ga.

J. G. Woodroof
Georgia Experiment Station
Experiment, Ga.

Ernest Wrens
VPI Extension Service
Dinwiddie, Va.

Clyde T. Yonng
Georgia Experiment Station
Experiment, Ga.

James H. Young
Nortb Carolina State University
Raleigh, N. C.

Paul B. Yonng
Duncan Hall
Auburn University
Auburn, Ala.