Partners in Progress
PEANUTS

# *Peanut Research at OSU 2000*

**Supported by the**

## Oklahoma Peanut Commission

**Oklahoma State University**
**Division of Agricultural Sciences and Natural Resources**
**Oklahoma Agricultural Experiment Station**
**Oklahoma Cooperative Extension Service**

**In cooperation with**
**U.S. Department of Agriculture - Agricultural Research Service**

**P-983**

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# Foreword

This publication is the sixth in a series of annual reports from the OSU Division of Agricultural Sciences and Natural Resources summarizing work supported by the Oklahoma Peanut Commission.

In his opening comments, Oklahoma Peanut Commission Executive Secretary Mike Kubicek points to two dual challenges of the 2000 growing season: dry and wet conditions and record cold and heat. OSU researchers experienced many of the challenges that these conditions presented to Oklahoma's peanut growers. However, much progress was made, and the research efforts of OSU scientists and others are presented here.

Our *Partners in Progress* series is intended to highlight the most recent significant research and extension activities. It is important that we view this year's efforts within the context of the past century and also examine what research and educational activity needs to come in the future if progress is to continue.

In partnership with the Oklahoma Peanut Commission, we strive to conduct research that is directed toward the needs of the state's producers. This report is just one way in which we communicate results to producers as rapidly as possible.

*D.C. Coston, Associate Director*
Oklahoma Agricultural Experiment Station
Division of Agricultural Sciences and Natural Resources
Oklahoma State University

## Oklahoma State University Division of Agricultural Sciences and Natural Resources Mission Statement

The Mission of the Oklahoma State University Division of Agricultural Sciences and Natural Resources is to discover, develop, disseminate, and preserve knowledge needed to enhance the productivity, profitability, and sustainability of agriculture; conserve and improve natural resources; improve the health and well-being of all segments of our society; and to instill in its students the intellectual curiosity, discernment, knowledge, and skills needed for their individual development and contribution to society.

# Risk reduction: A producer's dilemma - A researcher's goal

**Mike Kubicek, Executive Secretary,**
**Oklahoma Peanut Commission**

Weather was the big story in Oklahoma agriculture in 2000, especially for the peanut industry that suffered at the hands of "mother nature" through record drought *and* rainfall, as well as record heat *and* cold.

USDA estimates indicate that perhaps as much as one-third of the planted acres in 2000 were abandoned in the state, ironically due to both dry and wet conditions. Final average yield for Oklahoma may be as much as 500 lb/ac below the 1999 crop. Abandonment occurred because of irrigation demands and increased fuel costs during the growing season, making it one of the most expensive to produce.

Years like 2000 make grower's interest in risk management more acute. Over the years, the Oklahoma Peanut Commission has been awarding grants to Oklahoma State University peanut research and extension personnel to fund investigative and educational projects aimed at reducing producer risks. The overall goal is to improve efficiency and productivity, ultimately resulting in improved profitability for the 1000-plus producers that have provided the commission's funding for this important research.

Reports presented in this version of *Partners in Progress* highlight the annual results of on-going efforts in the areas of:

- breeding;
- production practices;
- disease management;
- weed control;
- insecticide field trials;
- and others.

Providing integrated strategies to risk management allows growers to more effectively and efficiently produce a profitable crop.

The many *partners* in this effort should be acknowledged. The primary investigators identified at the top of each report have earned the respect and appreciation of Oklahoma's peanut growers. The Oklahoma Peanut Commission salutes their efforts and the investments made by the OSU Division of Agricultural Sciences and Natural Resources, Oklahoma Agricultural Experiment Station, Oklahoma Cooperative Extension Service, USDA/Agricultural Research Service, and especially Oklahoma's peanut growers.

# Weed control research

**Don S. Murray, Department of Plant and Soil Sciences**
**R. Brent Westerman, Senior Research Specialist**
**Shea W. Murdock, Program Specialist**

***2000 progress made possible through OPC support***

- **Computer decision support system has successfully been adapted to Oklahoma growing conditions.**
- **Crownbeard can reduce peanut yields by more than 40 percent if not controlled.**

Experiments were conducted at both Ft. Cobb and Perkins to evaluate a twice-modified version of a computer decision support system originally developed by North Carolina State University (Herbicide Application Decision Support System-HADSS). In 1999, only half of the site was treated with Sonalan, and it was very apparent that a pre-plant incorporated herbicide treatment is essential for effective weed control. In 2000, the entire site was treated with Treflan. Additionally, one-half of the site was treated with Strongarm, while the other half was treated with Valor (an experimental pre-emergence herbicide; label expected in early 2001).

Various post-emergence herbicides were then used as recommended by either human sources or the computer decision support system. Morning glories and crownbeard were the two most uniform and dense weeds; however, Texas panicum was also present. Both Strongarm and Valor controlled the crownbeard. Follow-up post-emergence treatments suggested by both human sources and the computer program performed equally well in controlling the morning glories and Texas panicum.

Peanut yields from plots treated with herbicides recommended by the computer program were equal to the yields from plots treated with herbicides recommended by humans, indicating that the computer decision support system was operating properly. This program is one step closer to being released to the public through Internet access. If the validation in 2001 is successfully completed, the Oklahoma version of the program plus recommendations for pre-plant incorporated and pre-emergence herbicides will be made publicly available through the Internet.

A peanut-crownbeard competition experiment was conducted on a farmer's field that had a high, natural infestation of crownbeard. Plots were maintained weed-free for the entire season or weeds were removed every two weeks beginning four weeks after emergence. Crownbeard is the fourth most common and the third most troublesome weed in Oklahoma peanuts, and it is toxic to sheep, cattle, and swine. If the crownbeard were allowed to remain in the peanuts for the entire season, a yield reduction of over 40 percent would have occurred. This field had a high, natural infestation of crownbeard. For each week that the crownbeard was allowed to remain with the peanuts, was realized a 2.6 percent yield reduction.

# Continued development of peanut butter slices

Danielle D. Bellmer
Food and Agricultural Products Research and Technology Center
and Department of Biosystems & Agricultural Engineering



**2000 progress made possible through OPC support**

- **Product formulation and a large-scale processing method have been developed and proven for production of peanut butter slices.**
- **The effects of storage condition and package film type on the stability of the peanut butter slices has been evaluated.**
- **The peanut butter slice technology has been licensed to Kennedy Foods for commercial production and distribution.**

## Background

This work is a continuation of ongoing research involving development of a new peanut butter slice product. The product is a convenient, individually wrapped slice form of peanut butter, similar to cheese. The final product has a flavor and color nearly identical to peanut butter, and it is easily peelable from the wrapper. In addition, it has a shear-thinning texture that allows it to hold its shape but become soft when eaten. The final formulation consists of mostly peanut butter with a minimum number of added ingredients. The actual ingredients used will not be disclosed here in order to protect the intellectual property rights. The product has been successfully produced in a pilot plant setting. Several pilot test runs of the slices have been conducted in cooperation with American Dairy Brands in Plymouth, Wisconsin. The test runs were very successful, showing that the peanut butter slices could be processed at very high speeds (up to 800 slices/minute) on the cheese slice forming equipment.

The next steps in development have included an evaluation of the effects of storage condition and the type of packaging material used on the stability of the peanut butter slices. Fats naturally undergo spontaneous oxidation, which leads to rancidity, loss of palatability, and unwanted colors and odors. In order to prevent oxidation, foods containing fats are generally packaged in films that have low oxygen and moisture permeability. The plastic film that has been used to date to package the peanut butter slices is the same film that is used in packaging individually wrapped cheese slices. This film may or may not be the optimum for use with the peanut butter product. In addition, the optimum storage temperature of the slices is unknown. The main objective of this study was to evaluate chemical changes, specifically oxidative rancidity, in peanut butter slices when packaged in different types of plastic film materials and stored under various atmospheric conditions.

## Package and storage evaluation studies

Peanut butter slices were produced and poured into molds in the laboratory, and then sealed in different packaging film materials. Four different films containing varying levels of permeability to oxygen and moisture were used. Among them were:

- a high barrier coextruded film produced by Phillips Plastics specifically for this product (HB);
- standard Saran Wrap (SA);
- the PrintPack film that is traditionally used to package individually wrapped cheese slices (PP); and
- a much lower barrier film (LB).

Oxygen permeabilities ranged from 0.5 to 6900 cc/$m^2$ day, with the four films listed in ascending order of permeability as follows: HB< PP < SA < LB. Moisture permeabilities ranged from 3 to 24 g/$m^2$ day, with the four films listed in ascending order of moisture permeability as follows: HB< SA < PP < LB.

After being sealed in different types of film, samples were stored in the following four different atmospheric conditions:

- room temperature, moderate humidity (25°C, 45% RH);
- refrigeration temperature, low humidity (8°C, 5% RH);
- high temperature, moderate humidity (40°C, 45% RH); and
- high temperature, high humidity (40°C, 80% RH).

Samples were evaluated at seven different time intervals: after one week of storage and then once per month for six months. Samples were tested for oxidative rancidity using two common assays: the peroxide value (PV) and the thiobarbituric acid (TBA) assay. When an oil is oxidized, the first product formed is a hydro-peroxide; thus, a common method of detecting oxidative rancidity is by determination of the peroxide value. In the PV test, potassium iodide is added to a solution containing the sample, and a titration is used to determine the amount of iodine present, which is liberated in the presence of peroxide. The TBA assay is used to measure the presence of aldehydes, which are formed during storage of fatty products as peroxides break down. In this test, a particular aldehyde, malondialdehyde, reacts with the TBA reagent to give a red chromogen. The intensity of the red chromogen is measured with a spectrophotometer as an indication of the amount of aldehyde present.

Significant conclusions resulting from the package evaluation storage study on the peanut butter slices include the following:

- Oxidative changes began to develop in all four films within two months at all atmospheric conditions.
- Refrigerated conditions slowed rancidity development in three of the four packages.
- High temperature and high humidity accelerated the development of oxidative rancidity in all types of packaging.
- Low oxygen permeability was more important than low moisture permeability for prevention of oxidation.
- The high barrier film prevented oxidation better than the other three films.
- The low barrier film performed significantly worse than the other three films.
- Slices stored in high humidity experienced a significant darkening of color after about four months of storage in two of the packages (LB and SA).

Results from this study indicate that storage of the slices at refrigeration temperature could potentially significantly lengthen the shelf life of the product, which will be of great use during commercial development. While the product quality is still satisfactory at room temperature, it is not recommended that it be stored at higher temperatures or humidities. Results will be used to determine whether a higher barrier film will be economically beneficial for packaging of the peanut butter slices.

## Commercial development

The peanut butter slice technology has recently been licensed to Kennedy Foods, a new Oklahoma-based food company. Initial plans are to have the slices contract produced in an existing facility containing the necessary slice-forming equipment. Commercial distribution of the product is expected to begin during spring 2001, and it will be marketed under the name PB Slices. Targeted consumer groups include individual families, institutions such as schools and correctional facilities, and day care centers. Peanut butter slices may be available at local retailers sometime this year.

# Development of integrated strategies for management of soil-borne peanut diseases*

**Ken E. Jackson,**
**Hassan A. Melouk (USDA-ARS),**
**and John P. Damicone**
**Department of Entomology and Plant Pathology**

**2000 progress made possible through OPC support**

- **Sustained high temperatures during the peanut growing season was the prime factor in low incidence of Sclerotinia blight and other diseases.**
- **Due to low incidence of Sclerotinia blight, yield differences between susceptible and resistant breeding lines were not as great as in previous years.**
- **Five runner breeding lines exhibited acceptable level of resistance to Sclerotinia blight.**
- **One runner breeding line (TX977006, with enhanced oleic content) produced 900 lb/ac more than Florunner under low Sclerotinia pressure.**
- **A Spanish breeding line (TX962120, with enhanced oleic content) exhibited resistance to Sclerotinia blight and pod yield similar to Tamspan 90 and Spanco.**
- **A Spanish breeding line (TX 987236) had the highest pod yield and exhibited resistance to Sclerotinia blight.**
- **Four Spanish breeding lines exhibited resistance to Sclerotinia blight similar to Tamspan 90.**
- **The incidence of Sclerotinia blight in the Spanish peanut lines was lower than in the runner peanut lines.**
- **Early infection with the southern blight fungus drastically reduced pod yield in a micro plot.**

Peanut yield and grade are affected by several soil-borne pathogens. Sclerotinia blight is a major factor that limits peanut productivity in Oklahoma and other peanut-producing states. Sclerotinia blight is caused by a fungal pathogen that has a broad host range and is able to survive under adverse conditions for extended periods, sometimes for several years, by producing sclerotia (a black resistant fungal structure about the size of a sesame seed). The Sclerotinia blight disease has been and is continuing to be a major threat to peanut production in Oklahoma. Con-

*Two graduate students (one master's and one Ph.D.) are assisting in these investigations.

tinuous cropping of peanut favors buildup of sclerotial populations in soil level that often cause severe epidemics on an annual basis. Chemical management of Sclerotinia blight is necessary, but it is costly and often not effective with the currently registered fungicides. Research on southern blight was also initiated in 1996 to study the biology of the causal organism, pathogen variability, and timing of infection at various plant developmental stages. The ultimate goal of this research is to develop a disease management system for peanut production utilizing natural resistance with minimum inputs for sustaining profitability under the 1996 farm commodity program.

## Sclerotinia blight resistance research

This research has being conducted continually since 1982 to discover disease resistance in the peanut germplasm and breeding lines to the Sclerotinia blight fungus and other soil-borne pathogens. The incidence of Sclerotinia blight in many of the research plots, specially in the Spanish lines, at the Caddo Research Station near Ft. Cobb in 2000 was low (less than 25 percent) due to the sustained high temperatures during the growing season, especially August and September. Therefore, differences in Sclerotinia blight incidence and yield between susceptible and resistant breeding lines could not be ascertained in several of the field studies.

Several advanced Spanish and runner peanut lines, some with enhanced oleic acid content, from the breeding program at Texas A & M University and Oklahoma State University are being continually evaluated for resistance to Sclerotinia blight in field plots at multiple locations in Oklahoma and Texas. Several runner-type peanut-breeding lines with high oleic acid content exhibited had less Sclerotinia than the cultivar Florunner at the Caddo Research Station. Performance (Sclerotinia reaction, yield, grade and seed size) of a selected number of peanut breeding lines at the Caddo Research Station are shown in Table 1 and Table 2.

One of the Spanish breeding lines (TX962120, with enhanced oleic acid content) is being considered for release pending final evaluation of 2000 data from Texas locations. Seed increase of a top performing runner breeding line, with enhanced oleic content, is currently being performed in Puerto Rico for harvest in the spring of 2001.

## Southern blight research

A study was initiated in the 2000 growing season in a field at Stillwater utilizing micro plots to determine the effect of inoculating peanut plants at three developmental stages with sclerotia of the southern blight pathogen. Three peanut lines (Okrun, Tamrun 96, and TX 961678) were used in the study, and the research will be repeated in 2001. Plants were inoculated at 50, 75, and 100 days after planting (i.e., early flowering, early pod set, and beginning pod maturity). Disease readings were made throughout the duration of the experiment (142 days) with the final reading at seven days before harvest. Okrun data are presented in Table 3. Inoculation of plants with the southern blight fungus at 50 days after planting caused a drastic reduction in pod yield as compared with non-inoculated.

**Table 1. Sclerotinia blight reaction, yield, grade, and seed weight of runner peanut entries at the Caddo Research Station, 2000.**

| *Entry #* | *Entry I. D.* | *Yield* | *Dis. Inc.* | *Grade* | *100 sd.wt. (gm)* |
|---|---|---|---|---|---|
| 1 | TX 966205 | 3291 | 18% | 67% | 52 |
| 2 | TX 966151 | 3501 | 28% | 68% | 53 |
| 3 | TX 966018 | 3340 | 17% | 70% | 52 |
| 4 | TX 977236 | 3469 | 3% | 69% | 54 |
| 5 | TX 977053 | 3549 | 7% | 69% | 55 |
| 6 | TX 977006 | 4098 | 13% | 63% | 60 |
| 7 | TX 977045 | 3211 | 9% | 63% | 51 |
| 8 | TX 971738 | 3081 | 7% | 68% | 55 |
| 9 | TX 961678 | 3114 | 3% | 66% | 58 |
| 10 | TX 971783 | 3340 | 11% | 73% | 58 |
| 11 | TX 964117 | 1984 | 12% | 44% | 41 |
| 12 | TP 301-1-8 | 2565 | 13% | 66% | 49 |
| 13 | TP 296-4-4 | 2823 | 14% | 64% | 47 |
| 14 | AT 120 | 3194 | 11% | 68% | 58 |
| 15 | Tamrun 98 | 3162 | 9% | 68% | 53 |
| 16 | Flav. Run 458 | 2972 | 23% | 68% | 55 |
| 17 | Florunner | 3146 | 20% | 67% | 51 |
| 18 | Virugard | 3533 | 23% | 71% | 67 |
| 19 | Tamrun 96 | 3372 | 7% | 74% | 63 |
| 20 | GA Green | 3372 | 8% | 71% | 55 |

**Table 2. Sclerotinia blight reaction, yield, grade, and seed weight of Spanish peanut entries at the Caddo Research Station, 2000.**

| *Entry #* | *Entry I. D.* | *Yield* | *Yield with R-3* | *Dis. Inc.* | *Grade* | *100 sd.wt. (gm)* |
|---|---|---|---|---|---|---|
| 1 | Tamspan 90 | 2662 | 2339 | 1% | 70% | 40 |
| 2 | Spanco | 2735 | 2565 | 7% | 68% | 38 |
| 3 | TX 962120 | 2710 | 2452 | 1% | 67% | 41 |
| 4 | TX 963561 | 2759 | 2404 | 4% | 64% | 40 |
| 5 | TX 987112 | 2686 | 2436 | 4% | 67% | 42 |
| 6 | TX 987130 | 2735 | 2452 | 2% | 68% | 45 |
| 7 | TX 983564 | 2420 | 2097 | 1% | 64% | 41 |
| 8 | TX 987101 | 2614 | 2517 | 2% | 68% | 41 |
| 9 | TX 987222 | 2735 | 2517 | 4% | 69% | 38 |
| 10 | TX 987236 | 2735 | 2710 | 1% | 68% | 44 |
| 11 | TX 987117 | 2686 | 2372 | 4% | 68% | 44 |
| 12 | TX 963589 | 2396 | 2291 | 6% | 67% | 39 |
| 13 | TX 987249 | 1960 | 2049 | 11% | 68% | 37 |
| 14 | TX 987105 | 2178 | 2065 | 1% | 69% | 42 |
| 15 | TX 987857 | 2275 | 2243 | 3% | 68% | 42 |
| 16 | TX 987866 | 1912 | 1904 | 8% | 66% | 40 |
| 17 | TX 987833 | 2468 | 2355 | 6% | 65% | 47 |
| 18 | TX 987858 | 1767 | 1662 | 6% | 66% | 42 |
| 19 | TX 987851 | 2081 | 1904 | 8% | 69% | 41 |
| 20 | TX 987838 | 2009 | 2001 | 3% | 64% | 40 |

**Table 3. Reaction of Okrun to inoculation by the southern blight fungus at three plant developmental stages in a micro plot study at Stillwater, 2000.**

| *Treatment* | *Disease Rating [a]* | *Pod weight of 10 plants (g)* |
|---|---|---|
| Inoculated 50 DAP [b] | 3.7 | 18 |
| Inoculated 75 DAP | 2.3 | 32 |
| Inoculated 100 DAP | 1.7 | 42 |
| Non-inoculated | 1.0 | 43 |

[a] Disease rating 7 days before harvest: 1= 0% disease; 2 = < 25% disease (fungal mycelia on stem but no effect on plant); 3 = 25% disease (one wilted or dead stem); 4 = 50% disease (2 wilted or dead stems); 5 = 75% disease (3 wilted or dead stems); 6 = 100% disease (dead plant)

[b] DAP= days after planting.

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# Management of insect and disease incidence in peanuts

Phillip G. Mulder, Ken E. Jackson, and John P. Damicone
Department of Entomology and Plant Pathology
and Kelly Seuhs, Extension Assistant

**2000 progress made possible through OPC support**

- **Even with equal or higher insect (thrips) populations, a variety of peanut resistant to tomato spotted wilt virus (Tamrun 96) had a lower incidence and severity rating for the disease than a susceptible variety (Tamrun 98). These results were consistent over a two-year period.**
- **For the second year in a row, insecticides targeted at controlling thrips had no effect on incidence or severity of tomato spotted wilt virus (TSWV).**
- **No consistent differences in populations of thrips among the various treatments at three locations was observed. Overall, populations of thrips were down in three separate trials located in Bumeyville, Ft. Cobb, and Martha, Oklahoma.**
- **In 2000, no significant differences in yield were obtained between any of the treated or untreated peanuts at any of the three test sites.**
- **For the second year in a row, Tamrun 96 provided significantly greater peanut yields than did Tamrun 98.**
- **In a simulated defoliation trial on Spanish peanut at Ft. Cobb, Oklahoma, yields were consistently greater where plants were defoliated late in the season (90-119 days) as opposed to early in the season (45-67 days). Similarly, these younger plants undergoing greater levels of defoliation (8-10 larvae/ft of row) had lower yields than those exposed to low levels of defoliation (4 larvae/ft of row).**
- **A study conducted on runner peanut to assess the various miticides, used alone or in combination with user-friendly enhancement products, found no significant advantage to use of the additional products on overall control of mites during a 20-day period.**

## Thrips management and tomato spotted wilt virus

Since the introduction of tomato spotted wilt virus (TSWV) into Oklahoma in 1989, we have begun the task of evaluating how the use of insecticides and disease plant resistance can be manipulated to curb the encroachment of TSWV into the state. If managing the vector (thrips) by using insecticides can help in holding down the disease incidence, then these products may ultimately help in controlling the onslaught of this disease.

Results of the 2000 TSWV trial from Burneyville, Oklahoma, are presented in tables 1-4. In addition, a summary of the results from 1999 and 2000 on variety performance and insecticide efficacy are presented in Table 2 and Table 4, respectively. In the 2000 trials, runner type peanuts of two varieties were planted in 36-inch rows on May 24 at the Noble Foundation Red River Research Farm located in Burneyville. In-furrow insecticides were applied after planting using a hand-powered Precision Granular Applicator in a 7-inch band, calibrated to deliver the prescribed amount of insecticide over the open furrow. The furrow was then covered by hand, using a garden hoe. The Orthene hopperbox treatment was premeasured according to seeding rate and applied into the planting hoppers in thirds. To avoid any possible contamination, this treatment was the last planted. The post-emergent application of Orthene was applied after 90 percent emergence on June 16 using a $CO_2$ wheelbarrow plot sprayer.

Table 1 and Table 2 present the results of the analysis conducted across the two varieties. These varieties were chosen on the basis of their resistance. Tamrun 96 is resistant to TSWV while Tamrun 98 is considered susceptible to the disease. Thrips populations were slightly higher throughout the test in Tamrun 96 peanut, but these differences were only significant for the larvae sampled on the first reading three days after the post emergent treatment. (See Table 1.) These results were consistent with those obtained in 1999, with Tamrun 96 experiencing greater populations of thrips than Tamrun 98. The consistencies don't end there. In both years, while the thrips populations were higher in Tamrun 96 than in Tamrun 98, the incidence and severity

**Table 1. Effect of variety selection on thrips populations, Noble Foundation Red River Farm, Burneyville, Oklahoma, 2000.**

| | *Thrips population[1]* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *3 DAT* | | *7 DAT* | | *14 DAT* | | *22 DAT* | |
| *Variety* | *Adults* | *Larvae* | *Adults* | *Larvae* | *Adults* | *Larvae* | *Adults* | *Larvae* |
| Tamrun 96 | 4.9a | 21.7a | 1.8a | 8.1a | 3.5a | 1.3a | 0.9a | 1.6a |
| Tamrun 98 | 3.4a | 14.8 b | 1.0b | 11.2a | 2.2a | 1.2a | 0.4a | 1.1a |

[1]Thrips population based on a sample of 5 leaves/plot.
DAT = days after treatment.

**Table 2. Effect of variety selection and incidence (severity of TSWV) and peanut yield, Burneyville, Oklahoma, 1999 and 2000.***

| *Variety* | *TSWV % incidence[1]* | | *TSWV % severity[2]* | | *Yield (lb/ac)* | | *2000 Grade* |
|---|---|---|---|---|---|---|---|
| | *1999* | *2000* | *1999* | *2000* | *1999* | *2000* | |
| Tamrun 96 | 9.8a | 3.7a | 0.7a | 0.0a | 2476a | 3723a | 57 |
| Tamrun 98 | 30.5b | 31.0b | 6.1b | 2.1b | 1612b | 3162b | 57 |

* Means, within column, followed by the same letter are not significantly different (P=0.05, LSD).
[1] %TSWV incidence = Percent of plants showing TSWV symptoms.
[2] %TSWV severity = Percent of plants showing stunting and wilting caused by TSWV infection.

of TSWV was consistently and significantly higher in Tamrun 98. (See Table 2.) In addition, yields obtained during both years of this study, were significantly greater for Tamrun 96. (See Table 2.)

Tables 3 and 4 present the results of the analysis conducted across the various insecticide treatments. Initially, untreated peanuts had significantly greater larval thrips numbers than treated peanut. However, these differences were no longer evident in subsequent samples. (See Table 3.) Similar to results obtained in 1999, none of the peanut receiving an insecticide experienced lower incidence or severity of TSWV. (See Table 4.) Likewise, all the peanut treated with insecticide had yields similar to the untreated plants. (See Table 4.)

Based on two years of study, it appears that the incidence of TSWV in Oklahoma remains relatively low and occurs later in the season, making expression of the dis-

**Table 3. Effect of insecticides on thrips populations, Noble Foundation Red River Farm, Burneyville, Oklahoma, 2000.***

| | *Thrips population[1]* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Treatment/Rate* | *3 DAT* | | *7 DAT* | | *14 DAT* | | *22 DAT* | |
| *(a.i./A)[2]* | *Adults* | *Larvae* | *Adults* | *Larvae* | *Adults* | *Larvae* | *Adults* | *Larvae* |
| Temik 15G/1.0 lb. | 4.3ab | 16.7b | 1.5a | 6.5a | 2.3a | 1.4a | 0.5a | 1.0a |
| Orthene HB/0.19 lb. | 5.9a | 4.6c | 2.0a | 11.5a | 2.8a | 2.4a | 0.5a | 1.0a |
| Thimet 20G/1.0 lb. | 5.1a | 16.5b | 1.4a | 10.8a | 2.4a | 0.4a | 0.3a | 0.9a |
| Orthene 75S/0.5 lb. | 1.6b | 12.8bc | 1.3a | 8.9a | 3.3a | 1.3a | 1.0a | 2.4a |
| Untreated | 3.9ab | 40.4a | 0.9a | 10.5a | 3.5a | 0.8a | 0.9a | 1.5a |

*Means, within columns, followed by the same letter are not significantly different (P=0.05; LSD).
[1]Thrips populations based on a sample of 5 leaves/plot.
[2]Temik and Thimet were used at plant, in furrow. Orthene HB was used at plant, in the hopperbox and Orthene 75S was used as a postemergence spray.
DAT = days after treatment.

**Table 4. Effect of insecticides on incidence/severity of TSWV and peanut yield, Burneyville, Oklahoma, 1999 and 2000.***

| *Treatment/Rate* | *SWV % incidence[1]* | | *TSWV % severity[2]* | | *Yield (lb/ac)* | | |
|---|---|---|---|---|---|---|---|
| *(a.i./A)[3]* | *1999* | *2000* | *1999* | *2000* | *1999* | *2000* | *2000 Grade* |
| Temik 15G/1.0 lb. | 18.9a | 22.0a | 3.7a | 1.0a | 2142a | 3680a | 58 |
| Orthene HB/0.19 lb. | — | 20.4a | — | 0.9a | — | 3521a | 58 |
| Thimet 20G/1.0 lb. | 19.2a | 13.3a | 3.1a | 1.0a | 2173a | 3544a | 58 |
| Orthene 75S/0.5 lb. | 22.8a | 18.3a | 4.2a | 0.9a | 1969a | 3086a | 58 |
| Untreated | 18.9a | 12.6a | 3.7a | 1.5a | 1978a | 3380a | 55 |

* Means, within columns, followed by the same letter are not significantly different (P=0.05, LSD).
[1] % Incidence = percent of plants showing TSWV symptoms.
[2] % Severity = percent of plants showing stunting and wilting caused by TSWV infection.
[3] Temik and Thimet were used at plant, in furrow. Orthene HB was used at plant, in the hopperbox and Orthene 75S was used as a postemergence spray.

ease on the plant less severe. In addition, the use of an at-plant, hopperbox or post-emergent insecticide to control thrips is ineffective at reducing disease incidence or increasing yields. (See Table 3 and Table 4.) Higher yields obtained from TAMRUN 98 (See Table 2.) are, in part, due to resistance to TSWV but may also be a product of its superior agronomic qualities that appear consistently in many tests conducted across the state. All of these relationships may have changed had the populations of thrips been greater or the disease incidence been sooner and greater.

## Thrips management in areas unaffected by TSWV

Table 5 and Table 6 present results of insecticide management of thrips in an area of Oklahoma not affected by TSWV. Tests conducted on the Caddo Research Station at Ft. Cobb, Oklahoma, using conventional insecticides often chosen by growers, showed few differences in level of thrips control. (See Table 5.) In addition, no significant differences in yield were obtained from these same trials. (See Table 6.) Initially (three and eight days after treatment), larval thrips populations in untreated peanut were significantly greater than treated peanut, but these differences did not last as the crop approached the bloom period. Based on results of yield analysis of these treatments and comparing the economic returns after adjusting for grade, value and cost of control, none of these treatments represent a reasonable investment risk. (See Table 6.) This is indicative of many studies conducted on thrips management in Oklahoma. The inconsistencies associated with many at-plant and/or prophylactic treatments for thrips control cast an unreliable shadow on the yearly benefits often given these products. (See Table 6.)

## Defoliator simulation studies

Table 7 presents the results of studies conducted to elucidate the effects of defoliation on Spanish peanut (Tamspan 90). These tests were conducted on the Caddo Research Station. At 45, 60, 75, 90, and 112 days after planting, defoliation of plants was mechanically accomplished using

**Table 5. Effect of insecticides on thrips populations, Ft. Cobb, Oklahoma, 2000.**

| Treatment/Rate (a.i./A)[1] | *Thrips populations*[*2] 3 DAT Adults | 3 DAT Larvae | 8 DAT Adults | 8 DAT Larvae | 13 DAT Adults | 13 DAT Larvae |
|---|---|---|---|---|---|---|
| Temik (1.0 lb.) | 1.2bc | 9.5b | 1.0b | 2.2b | 2.7a | 2.7a |
| Temik (0.6 lb.) | 3.0bc | 16.7ab | 1.5ab | 8.7b | 3.2a | 3.5a |
| Thimet (1.0 lb.) | 9.5a | 7.5b | 1.0b | 6.5b | 2.5a | 0.5a |
| Orthene HB (0.19 lb.) | 2.2bc | 0.2b | 1.5ab | 3.2b | 2.0a | 1.7a |
| Orthene I (0.33 lb.) | 4.0b | 1.0b | 1.5ab | 0.7b | 2.2a | 3.7a |
| Orthene I (0.66 lb.) | 2.7bc | 0.2b | 0.5b | 1.2b | 1.7a | 0.5a |
| Orthene 75S (0.5 lb.) | 0.5c | 3.2b | 0.2b | 7.7b | 2.2a | 0.2a |
| Untreated | 8.5a | 31.7a | 3.0a | 21.5a | 1.0a | 1.2a |

*Means, within columns, followed by the same letter are not significantly different (P=0.05; LSD).
[1]Temik, Thimet and Orthene HB were at-plant treatments placed in furrow. Orthene I were at-plant treatments injected into the furrow and Orthene 75S was a post-emergence treatment made on 6-16-00.
[2]Thrips populations based on a sample of 5 leaves/plot.

**Table 6. Effect of thrips insecticides on peanut yield, grade and value, Ft. Cobb, Oklahoma, 2000.**

| *Treatment/Rate (a.i./A)*[1] | *Mean yield** | *Mean grade (% TSMK)* | *Mean value ($/A)* | *Cost ($/A)*[2] | *Return ($/A)*[3] |
|---|---|---|---|---|---|
| Temik (1.0 lb.) | 4202a | 73 | 1306 | 24 | 1282 |
| Temik (0.6 lb.) | 4233a | 73 | 1307 | 14 | 1293 |
| Thimet (1.0 lb.) | 4079a | 73 | 1261 | 11 | 1250 |
| Orthene HB (0.19 lb.) | 4246a | 70 | 1270 | 3 | 1267 |
| Orthene I (0.33 lb.) | 4220a | 72 | 1299 | 7 | 1292 |
| Orthene I (0.66 lb.) | 4320a | 72 | 1326 | 13 | 1313 |
| Orthene 75S (0.5 lb.) | 4057a | 72 | 1244 | 10 | 1234 |
| Untreated | 4075a | 73 | 1259 | 0 | 1259 |

*Means, within columns, followed by the same letter are not significantly different (P=0.05; LSD).

[1]Temik, Thimet and Orthene HB were at-plant treatments placed in furrow. Orthene I were at-plant treatments injected into the furrow and Orthene 75S was a post-emergence treatment made on 6-16-00.

[2]Treatment costs = cost of insecticide only for at-plant applications (Temik, Thimet, Orthene HB, Orthene I); for Orthene postemergence application, cost = insecticide cost ($7.00) + application ($3.00).

[3]Partial return = (crop value) - (treatment costs).

**Table 7. Effect of simulated defoliation on Spanish peanut yield and grade at Ft. Cobb, Oklahoma, 2000.**

| | *Yield (lb/ac)* Larvae/ft. of row* | | | | | |
|---|---|---|---|---|---|---|
| *Days after planting* | *4* | *6* | *8* | *10* | *Mean yield* | *Mean grade* |
| 45-52 | 2958a | 2777acd | 2251d | 2468bcd | 2614 | 66.9 |
| 60-70 | 2850ac | 2850ac | 2577bcd | 2350cd | 2657 | 64.4 |
| 75-82 | 2768acd | 2750acd | 2641acd | 2505bcd | 2666 | 65.4 |
| 90-97 | 2813abcd | 2958ab | 2840abc | 2958ab | 2893 | 65.7 |
| 112-119 | 2986ab | 3167a | 3022ab | 2894abc | 3017 | 66.6 |
| Untreated | — | — | — | — | 2677abcd | 66.5 |
| Means | 2875 | 2900 | 2666 | 2635 | | |

*Means followed by the same letter are not significantly different (P=0.05; LSD).

scissors. Simulation took place over a two-week period to account for the approximate amount of time a damaging caterpillar population would be present. Four levels of defoliation were exerted on the plants to simulate 4, 6, 8, and 10 larvae per foot of row. During the conduct of this trial, caterpillar pests were discourage by two applications of Confirm 2F (tebufenozide). Yield results revealed that the earlier in the season defoliation occurred, the greater the effect at harvest. However, none of the yields obtained were significantly greater than the untreated peanut. The only differences in yield attributable to timing and infestation level occurred when younger peanuts (45-60 days after planting) were heavily defoliated (8-10 larvae per foot of row). These peanuts did experience some significant losses in yield. (See Table 7.) In future tests of this nature, a more realistic defoliation technique will have to be used and greater pressure on the plants will have to be exerted.

## Miticide evaluation studies

Table 8 summarizes the results of an efficacy trial conducted to evaluate performance of various miticide products in runner peanut. On September 20, a field for these evaluations was identified in Jimtown, Oklahoma. This field had been sprayed previously for grasshoppers around the border and, hence, had developed an infestation of twospotted spider mites. Products evaluated in this trial included materials that growers presently use and other materials that are considered possible alternatives and/or enhancers. Application was made using a $CO_2$ wheelbarrow plot sprayer calibrated to deliver 20 gallons per acre. Evaluations were conducted 7, 13 and 20 days after treatment by randomly selecting five leaves per 20 foot plot and examining an area of 2.5 $cm^2$ under a 10X hand lens.

Results from this trial showed the best levels of control with Comite and Kelthane. (See Table 8.) Control of mites with Capture and the other additives did not perform poorly throughout the test, but noticeable differences in total numbers of mites in these treatments were evident. (See Table 8.) Comite, Capture, Naturalis-L, Stirrup-M, and Sulfur are presently labeled for use on peanut while Kelthane is not. The addition of the "enhancers" (Naturalis-L, Stirrup-M) did not appear to increase the efficacy of any of the products evaluated in this trial. (See Table 8.)

Naturalis-L is a fungal biopesticide that certainly should show some promise in controlling mites. Stirrup-M is a behavior-modifying chemical that is supposed to increase mite-searching capacity. The hope for this latter material lies in the tank-mix combination with a more toxic component. In light of the type of conditions these materials were evaluated under it would be unfair to suggest that they may not have a place in further trials or in management of other organisms in peanut.

**Table 8. Effect of miticides on mite populations (2.5 $cm^2$) in runner peanut, Jimtown, Oklahoma, 2000.**

| | *Mean No. Mites/2.5 $cm^2$** | | | |
|---|---|---|---|---|
| *Treatment (Rate-Actual/A)* | *7 DAT* | *13 DAT* | *20 DAT* | *Total* |
| 1) Sulfur 6L (1 qt) + Stirrup (2 oz) + Naturalis-L (10 oz) | 1.7ab | 3.9ab | 5.0 ab | 10.6ab |
| 2) Capture 2EC (2.6 oz) + Stirrup (2 oz) | 1.1ab | 8.9a | 8.6ab | 18.6ab |
| 3) Comite (2 pts) + Stirrup ( 2 oz) | 0.4ab | 0.5b | 0.5b | 1.3b |
| 4) Comite (2 pts) | 0.1b | 1.1ab | 0.9b | 2.0b |
| 5) Capture (2.6 oz) + Naturalis-L (10 oz) | 2.0a | 7.6ab | 8.7ab | 18.2ab |
| 6) Capture (2.6 oz) + Naturalis-L (10 oz) + Stirrup-M (2 oz) | 2.0a | 7.7ab | 14.1a | 23.8a |
| 7) Kelthane MF (1.5 pts) | 0.5ab | 0.4b | 0.7b | 1.7b |
| 8) Untreated | 1.1ab | 4.0ab | 0.6b | 4.7ab |

*Means, within columns, followed by the same letter are not significantly different (P=0.05, LSD).

# Peanut breeding and varietal enhancement

**Kent Keim, Jim Kirby, and Tom Stevens**
**Department of Plant and Soil Sciences**

**2000 progress made possible through OPC support**

- **Twelve runner and Virginia entries evaluated in Uniform Peanut Performance Test (UPPT).**
- **OK-B26 line released as "Jupiter."**
- **Twenty high oleic Virginia lines in preliminary replicated evaluation.**
- **Fifty Virginia lines in replicated, intermediate evaluation.**
- **Sixty high oleic acid lines in intermediate, replicated evaluation.**
- **Twenty runner lines in each of preliminary and intermediate replicated evaluation.**
- **Ten Spanish lines in preliminary, replicated evaluation.**
- **Twenty Spanish lines in intermediate, replicated evaluation.**
- **Eighty Spanish and runner lines from Texas evaluated in four replicated tests in cooperative effort.**
- **Three hundred fifty high oleic acid lines in single replication plots for observation and selection.**
- **Twenty-five $F_1$ high oleic acid populations grown for generation advance.**

Yield test and breeding materials were grown at the Caddo Research Station, Ft. Cobb, Oklahoma, in 2000. Evaluations included all four peanut market types; Spanish, runner, Virginia, and valencia (observation only). The stage of development ranged from advancing new breeding populations to a new variety release. Yield tests included runner, Virginia, and Spanish market types. Levels of yield testing involved preliminary, intermediate, and advanced evaluation. A total of 1,250 yield test plots were planted and harvested.

Line OK-B26 was released and given the name, "Jupiter." Jupiter is a large-seeded Virginia-type peanut with a bunch-type growth habit and plant size very similar to NC7. NC7 has been the predominate variety grown in this class in the southwest. Primary use of large-seeded Virginia production in the southwest is as an in-shell product. For the in-shell market, pod appearance is of primary importance. Pods with blemishes caused by the disease pod rot are not acceptable for the in-shell market. Jupiter has shown improved levels of pod rot resistance compared to NC7. Jupiter has also demonstrated improved pod yield levels over NC7 in the southwest region. Jupiter represents a direct result of breeding and selection practiced in the same area as that intended for the variety's commercial production.

Cooperative research continued with the Texas peanut-breeding program. The cooperative effort is directed at developing high oleic acid peanuts for the southwest-growing region. Four yield tests from the Texas breeding program were grown. Tests contained runner and Spanish types. Each test contained 20 lines.

The Oklahoma breeding program continues to have development of high oleic acid varieties as a priority area. Three replicated yield tests involving high oleic acid lines were conducted. Those tests contained a total of 80 lines. The vast majority of lines in those tests were derived from crosses using NC7. Lines expressed a great array of plant, pod, and seed morphology.

Disease resistance is an integral component of the breeding program. Sclerotinia is the most prominent disease, and resistance is a most important characteristic for any new variety. A test containing 30 Virginia lines was grown in an area having high occurrence of sclerotinia. Environmental conditions were not conducive to disease development. Such factors precluded obtaining disease ratings, limiting the experiment to determining yield and quality. Another disease of concern is tomato spotted wilt virus (TSWV). The disease is currently a problem in Texas, and it is moving northward. Progress and dynamics of TSWV will need to be monitored and considered in relation to the Oklahoma breeding program and cooperative breeding with Texas.

Several other activities represented components of the breeding program. Another 350 high oleic acid lines were grown in single replication plots for observation and selection. Lines were in the $F_5$ or $F_6$ generation of inbreeding. These lines represent a substantial base as a new series for preliminary yield evaluation in 2001. Lines displayed a great deal of variation for plant, pod, and seed characteristics, but originated from one base population utilizing only two parent lines. Generations for $F_2$, $F_3$, and $F_4$ breeding materials were grown for selection and advancement. A total of 62 $F_4$ lines were grown. One population utilizing two parent lines represented the $F_4$ generation. In the $F_3$ generation, 500 lines selected from eight populations were grown. Populations in the $F_3$ generation represented combinations involving 10 parent lines. Seven $F_2$ populations utilizing 10 parents were grown during 2000 at the Caddo Research Station. These populations "offset" winter nursery production for the same populations in Puerto Rico, during the winter of 1999-2000. These procedures limited liability to and impact of natural risks (e.g. hurricane, freeze, hail), which might have occurred at a nursery location, enabled growing adequate $F_2$ population sizes, and they provided for more efficient utilization of research resources.

Twenty-five $F_1$ populations resulting from hand hybridization in 1999 were grown to produce $F_2$ seed. Construction of $F_1$ populations was directed at incorporating the high oleic acid trait into varieties adapted to the southwest region. Populations represented combinations between 12 parent lines. In addition to the high oleic acid trait, lines used as parents were chosen based on performance for yield, quality, earliness, and sclerotinia resistance. Parent lines used represented both runner and Spanish types.

The Oklahoma breeding program has had the most success in developing lines utilizing crosses with NC7. Jupiter is an example. A major objective of the year's breeding effort was to improve depth and diversity of the Oklahoma peanut-breeding program. Current and continued efforts will be directed at developing high oleic varieties incorporating other genetic sources. At the same time, breeding materials will be selected and developed with respect to agronomic, quality, and market characters for successful production in the southwest region.

# Management of Sclerotina blight and Verticillium wilt in peanuts

**Ken E. Jackson and**
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**Department of Entomology and Plant Pathology**

**2000 progress made possible through OPC support**

- **All advanced peanut-breeding lines at Weger's farm near Durant produced higher yields than at Kell's farm near Chickasha.**
- **Peanut lines yields and grades at both Kell's and Weger's farms were lower than averages for previous years.**
- **A high oleic breeding line TX 961678 exhibited high resistance to Sclerotinia blight and limb rot at the Weger's location.**

This project addresses research to investigate disease resistance in managing important soil-borne peanut pathogens in Oklahoma, particularly Sclerotinia blight, Verticillium wilt, and southern blight. The objective of this study was to evaluate the reaction of peanut lines, including the Sclerotinia-resistant advanced breeding lines (some with high O/L ratios), to the Verticillium wilt fungus, and other pathogens under field conditions.

## Reaction of peanut lines to endemic pathogens in small field plots at Chickasha and Durant in 2000

Field plots were planted on May 11, 2000 at Kell's farm near Chickasha and at Weger's farm near Durant on May 10. Plots were harvested at Kell's on October 18 and at Weger's on October 27, 2000.

Eight peanut cultivars and breeding lines were included in this study at each location. Each plot consisted of two 20-foot rows, 3 feet apart, with four replications. The incidence of foliar and soil-borne diseases at Kell's during the 2000 growing season was very low for a meaningful evaluation, and therefore disease readings were not taken. Disease incidence (Sclerotinia, southern blight, and limb rot) at Weger's was light. (See Table 1.) Yield and grade at Kell and Weger farms are presented in Table 2.

## Incidence of Verticillium wilt

Incidence of Verticillium wilt on peanuts during the 2000 growing season in Oklahoma was at trace levels. The Verticillium

**Table 1. Reaction of selected peanut breeding lines to several pathogens at Weger's farm near Durant, Oklahoma, 2000.**

| *Entry* | *Sclerotinia blight (%)* | *Southern blight incidence*[a] | *Limb rot severity*[b] |
|---|---|---|---|
| Okrun | 16 | 5.5 | 2.8 |
| Tamrun 96 | 11 | 2.3 | 2.6 |
| TX 961678 | 7 | 0.5 | 0.6 |
| TX 961738 | 11 | 0.3 | 1.8 |
| TX 971783 | 18 | 1.5 | 3.8 |
| GA Green | 15 | 0.5 | 2.3 |
| TX 961507 tan | 8 | 1.0 | 3.0 |
| GA 942007 | 5 | 0.0 | 0.9 |

[a] Number of hits/40 ft
[b] Based on a 0-6 disease rating scale with 0= no disease and 6= high level of disease severity.

wilt fungus was isolated from Okrun grown in a commercial field in west Texas, near Seminole. The entire field was uniformly infected with the Verticillium wilt fungus. Wilt severity was low, and the impact on pod yield and grade was minimal. This information is important in providing background information on the effect of Verticillium wilt on yield and grade of Okrun. The pathogenicity of this isolate on several peanut cultivars will be evaluated during 2001 in the greenhouse.

Application rates used for Capture 2EC were half of the suggested rate used in the Section 18 obtained for Oklahoma in 2000. Therefore, performance of this material on mites should not be taken out of context for a single study conducted in one year at a lower-than-label rate. In previous trials conducted in southcentral Oklhaoma, Capture provided excellent control at the 5.12-ounce rate. This material has been granted a Section 18 exemption for the 2001 growing season.

**Table 2. Yield and grade of selected peanut breeding lines at two locations in Oklahoma, 2000.**

| *Entry* | *Yield (lb/ac) at location* | | *Grade at location* | |
|---|---|---|---|---|
| | *Weger* | *Kell* | *Weger* | *Kell* |
| Okrun | 3630 | 2986 | 68 | 62 |
| Tamrun 96 | 4111 | 3058 | 66 | 64 |
| TX 961678 | 3812 | 2695 | 66 | 62 |
| TX 961738 | 3467 | 2523 | 64 | 66 |
| TX 971783 | 3684 | 2659 | 67 | 66 |
| GA Green | 3312 | 2741 | 62 | 64 |
| TX 961507 tan | 3312 | 2641 | 66 | 63 |
| GA 942007 | 3821 | 2523 | 62 | 72 |

# Results of applied research on peanuts – 2000

**Ron Sholar and Jerald Nickels**
**Department of Plant and Soil Sciences**

***2000 progress made possible through OPC support***

- **In six variety tests conducted during 2000, runner peanut varieties averaged 781 lb/ac and 2 percent Total Sound Mature Kernels higher than Spanish varieties. Tamrun 96 was the highest yielding variety tested for the fifth consecutive year.**
- **Strongarm, a new broadleaf, PPI herbicide, demonstrated excellent activity on a broad spectrum of troublesome weeds in Oklahoma peanut fields. Valor, an experimental soil applied herbicide was also effective in controlling a broad spectrum of weeds and showed good crop safety.**
- **The long drought and low disease incidence masked benefits from both rotation and disease control.**
- **Inoculation tests showed that new inoculants can consistently produce higher numerical yields, but rarely are the differences statistically significant. Grades were not affected by the treatments. Late season nitrogen fertilizer treatments (50 and 100 lb/ac of actual N) had no effect on pod yields or quality.**
- **A seeding rate test demonstrated that there is no difference in yields from varying seeding rates, as long as an adequate amount of seed is planted.**

## Background

The Oklahoma and U.S. peanut continues to undergo changes. Rising production costs, disease problems, and other concerns have continued to result in a shift of peanuts from eastern to southwestern Oklahoma. Five southwestern counties now account for 25 percent of Oklahoma's 80,000-acre peanut crop. Oklahoma's peanut acreage has dropped from 125,000 acres in 1980 to around 85,000 acres planted in 2000.

However, peanuts remain one of the few farm commodities offering acceptable potential for a positive return to growers. Profit margins are very narrow as costs of production have risen and prices paid to producers have remained as established by the 1996 Farm Bill. Growers must adopt innovative management strategies to remain competitive in the peanut industry.

The following applied research was conducted to assist growers to remain competitive in the peanut industry. The applied research in peanuts conducted by the Department of Plant and Soil Sciences focuses on the introduction and demonstration of new and appropriate technology for Oklahoma conditions. *The objective is to assist growers in developing management strategies that will result in more economical production.* The importance that the peanut industry has placed on delivery of a high quality product is also a focal point.

## 1. Variety testing

The purpose of the variety testing program is to evaluate the performance of new varieties and to compare that performance to varieties currently available. In 2000, variety tests were conducted in of Caddo, Love, Hughes, Grady, Bryan, and Jackson counties. Sclerotinia blight was not a major problem at any of the locations in 2000.

The summer's long drought impacted the 2000 crop and also these research results. Because all locations were irrigated, the negative effects of the drought were somewhat mitigated. Despite the availability of irrigation, extremely high temperatures delayed flower and pod set and pod fill. Quality was lower than in some years.

Yields were extremely low at Love County and were exceptionally high at Jackson County. Yields at other locations were about average. The location at Jackson County is a flood-irrigated field that has only a very recent history of peanut production. This no doubt contributed to the extremely high yields. In this test, Okrun yielded 7134 lb/ac, which is the highest yield obtained in the past 20 years of variety testing.

Grades reflect the variable weather that characterized the harvest season. The highest grade obtained was 76 percent TSMK.

The following varieties have demonstrated the best potential for Oklahoma.

**Tamrun 96** — This variety was developed by Texas A&M University and was released in 1996. This variety has resistance to tomato spotted wilt virus (TSWV), a disease that to date has resulted in relatively small problems in Oklahoma. However this disease is causing severe losses in the southeastern United States and in some areas of Texas.

In 1999, this variety averaged 4129 lb/ac at five locations and in 2000 averaged 4010 lb/ac at six locations. This variety tends to grade 1 to 2 percent lower than Okrun. It has consistently been the highest yielding variety in statewide variety tests conducted during 1997-2000. Tamrun 96 also has demonstrated some Sclerotinia blight resistance. As an example, in 1998 test in Bryan County under Sclerotinina blight pressure, Tamrun 96 yielded 3872 lb/ac compared to 2105 lb/ac for Okrun.

**Georgia Green** — Released by the University of Georgia, 1998 was the first year for this variety in the Oklahoma variety tests. The performance of this variety was good at all locations in 1998 and 1999. Georgia Green tends to mature a little earlier and grade a little higher than Tamrun 96. In six tests in 2000, Georgia Green averaged 386 lb/ac while Tamrun 96 averaged 4010 lb/ac. In the same tests, Georgia Green averaged 71 percent TSMK and Tamrun 96 averaged 69 percent TSMK.

**Table 1. Peanut variety tests, 2000.**
Average of Six Tests[1]

| Variety | Market type | Yield (lb/ac) | Grade (%TSMK)[1] | Gross return ($/ac) |
|---|---|---|---|---|
| Spanco | Sp | 3178 | 67 | 930 |
| Tamspan 90 | Sp | 2883 | 67 | 847 |
| Okrun | Ru | 3981 | 70 | 1227 |
| Florunner | Ru | 3892 | 70 | 1201 |
| AT-120 | Ru | 3455 | 67 | 1039 |
| Tamrun 96 | Ru | 4010 | 69 | 1218 |
| Hughes Runner | Ru | 3718 | 70 | 1159 |
| Georgia Green | Ru | 3868 | 71 | 1203 |
| Tamrun 98 | Ru | 3757 | 69 | 1151 |
| **LSD 0.05** | | **290** | **1.6** | **97** |

Average of Six Counties (18 obs.) @ Bryan, Caddo, Grady, Hughes Jackson and Love

**Table 2. Peanut variety tests, 1999 and 2000.**
Average of Five Counties[1] for Two Years

| Variety | Number obs. | Market type | Yield (lb/ac) | Grade (%TSMK)[1] | Gross return ($/ac) |
|---|---|---|---|---|---|
| Spanco | 30 | Sp | 2866 | 66 | 818 |
| Tamspan 90 | 30 | Sp | 2822 | 66 | 812 |
| Okrun | 30 | Ru | 3685 | 70 | 1127 |
| Florunner | 30 | Ru | 3765 | 70 | 1153 |
| AT-120 | 30 | Ru | 3373 | 69 | 1015 |
| Georgia Green | 30 | Ru | 3702 | 70 | 1130 |
| Tamrun 96 | 30 | Ru | 4059 | 69 | 1211 |
| Tamrun 98 | 30 | Ru | 3378 | 69 | 1010 |
| **LSD 0.05** | | | **511** | **2.2** | **163** |

[1] Average of Five Counties for 1999-2000 (30 obs.) @ Bryan, Caddo, Grady, Hughes and Love
Does not include Jackson Co. results from 2000

## 2. Peanut rotation study (joint project with the Noble Foundation)

Peanuts are susceptible to a wide range of foliar and soil-borne diseases. Peanut fields rotated with other crops are generally less susceptible to foliar and soil-borne diseases, weed problems, and soil insects. Higher yields, grades, and gross returns are usually achieved if a rotation plan is followed. In 1991, a cooperative project was started with the Noble Foundation to demonstrate the benefits of rotating peanuts with corn, grain sorghum, and cotton compared to continuous peanuts. This project will be continued for several years.

### *General Results*

A long-term rotation study was established in 1990 on land that had not been planted to peanuts in the previous 14 years. In 1990, plots were planted to either cotton, grain sorghum, corn, or peanuts. In 1991, the plots were planted with one of these crops according to a long-term crop rotation plan. In 2000, only two systems were planted to peanuts.

### *Spanco Summary:*

Because of the drought, disease incidence was low and there was little or no



**Table 3. Peanut rotation test, 2000**
**Red River Farm, Burneyville, Oklahoma.**
Yields for Spanco Test

| *Rotation system* | *Bravo alone lb/ac* | *Bravo + Folicur lb/ac* | *Advantage of Bravo + Folicur over Bravo alone lb/ac* |
|---|---|---|---|
| P-P-P-P-P-P-P-P-P-P-P[1] | 2179 | 2102 | -77 |
| P-M-C-P-M-P-P-M-M-P-P | 2062 | 2149 | 87 |
| Average | 2126 | 2121 | +5 |
| | | **+ 5(compared to Bravo alone)** | |

[1]Test started in 1990. This code shows the crops that have been grown the 10 years of the test.
P = Peanuts; M = Maize (Corn); C = Cotton; S = Grain Sorghum

Soil Type - Minco fine sandy loam
Seeding Rate - 90 lb/ac
Planted - **May 24, 2000**, 36" rows
Harvested -**Oct 12, 2000**

**Table 4. Peanut rotation test, 2000**
**Red River Farm, Burneyville, Oklahoma.**
Yields for Okrun Test

| *Rotation system* | *Bravo alone lb/ac* | *Bravo + Folicur lb/ac* | *Advantage of Bravo + Folicur over Bravo alone lb/ac* |
|---|---|---|---|
| P-P-P-P-P-P-P-P-P-P-P[1] | 2338 | 2686 | 348 |
| P-M-C-P-M-P-P-M-M-P-P | 2331 | 2173 | -158 |
| Average | 2335 | 2430 | +95 |
| | | **+95 (compared to Bravo alone)** | |

[1]Test started in 1990. This code shows the crops that have been grown the 10 years of the test.
P = Peanuts; M = Maize (Corn); C = Cotton; S = Grain Sorghum

Soil Type - Minco fine sandy loam
Seeding Rate - 90 lb/ac
Planted - **May 24, 2000**, 36" rows
Harvested -**Oct 12, 2000**

response to Folicur. Further, after 11 years, yields in the continuous peanut plots were slightly higher than the yields in the rotation plot. The exact reason for this is unclear. The year 2000 was extremely hot and yields were very low. It is possible that the high temperatures and low yields mask any advantages for the rotation system. It should also be noted that in the rotation plots, peanuts were planted in 1999 and again in 2000.

Yields with Folicur were actually 77 lb/ac (2102 vs. 2179) lower in continuous peanuts than the Bravo alone treatment. Yields in the rotation plot where Folicur was used were only 87 lb/ac (2149 vs. 2062) higher than the Bravo alone treatment. When rotation and Folicur were used in combination, yields were actually no greater than where no rotation and no Folicur were used.

***Okrun Summary:***

After 11 years, yields in the continuous peanut plots were slightly higher than the yields in the rotation plot. The exact reason for this is unclear. The year 2000 was extremely hot and yields were very low. It is possible that the high temperatures and low yields mask any advantages for the rotation system. It should also be noted that in the rotation plots, peanuts were planted in 1999 and again in 2000.

Folicur increased yields by 348 lb/ac (2686 vs. 2338) in continuous peanuts. Yields in the rotation plot where Folicur was used were 158 lb/ac (2173 vs. 2331) lower than the Bravo alone treatment. When rotation and Folicur were used in combination, yields were actually no greater than where no rotation and no Folicur were used.

## 3. Variety X herbicide test

Three herbicides were tested on six varieties at four locations. The herbicides are listed in Table 5. The varieties were Okrun, Tamrun 96, Tamrun 98, AT 120, Georgia Green, Tamspan 90, and Jupiter. The purpose was to determine whether the varieties would respond differentially to the herbicides. It was determined that the all varieties had good tolerance to these herbicides and there would be no reason for growers to take extra precautions when using these herbicides.

## 4. Peanut inoculation tests

A peanut inoculation test was conducted on the Caddo Research Station in 2000 on old peanut land that was irrigated.

**Table 5. Variety X herbicide summary, 2000.**
Average of four tests

| *Herbicide* | *Obs.* | *Yield (lb/ac)* | *Grade (% TSMK)* |
|---|---|---|---|
| Strongarm 84 WG 0.45 oz/ac | 72 | 3816 | 70 |
| Valor 50 WP 3 oz/ac | 72 | 3806 | 70 |
| Cadre 70 DF 1.44 oz/ac | 72 | 3712 | 70 |
| Weed free Hand weeded | 72 | 3779 | 70 |

## Table 6. Peanut inoculation trial, 2000.
Caddo Research Station, Caddo County

| *Treatment* | *Yield (lb/ac)* | *Grade (%TSMK)*[1] | *Gross return ($/ac)* |
|---|---|---|---|
| Untreated control | 3421 | 72 | 1057 |
| Urbana-Rhizoflo/Granular Infurrow (5 lb/ac) | 3303 | 67 | 966 |
| Urbana-Liquid Prep / Liquid Infurrow (14.4 oz/ac) | 3467 | 72 | 1078 |
| Urbana-Mega Prep Sterile Humus / Seed Trt. | 3675 | 69 | 1105 |
| Lipha Tech-Lift / Liguid Infurrow (13 oz/ac) | 3630 | 68 | 1066 |
| Lipha Tech @Peanut Special / Seed Trt. | 3848 | 69 | 1160 |
| Rhizoflo (5 lb/ac) + Nitrogen @ 103 DAP / (50 lb/ac) | 3730 | 65 | 1058 |
| Rhizoflo (5lb/ac) + Nitrogen @ 103 DAP / (100 lb/ac) | 3539 | 72 | 1101 |
| **LSD 0.05** | **ns** | **2.2** | **ns** |

[1] % TSMK = % Total Sound Mature Kernels

Planting Date @ May 18, 2000
Variety @ Tamrun 96
Nitrogen (34-0-0) @ August 29, 2000
Digging Date @ October 16, 2000
Growing Season @ 153 Days
Average Yield @ 3577 lb/ac; Untreated 3421 lb/ac; Treated 3599 lb/ac (200 # Increase)

## Table 7. Peanut inoculation test, 2000.
Phillip and Matt Muller Farm, Jackson County

| *Treatment* | *Yield (lb/ac)* | *Grade (%TSMK)*[1] | *Gross return ($/ac)* |
|---|---|---|---|
| Untreated control | 5242 | 74 | 1673 |
| Urbana-Rhizoflo/Granular Infurrow (5 lb/ac) | 5578 | 72 | 1740 |
| Urbana-Liquid Prep / Liquid Infurrow (14.4 oz/ac) | 5426 | 73 | 1720 |
| Urbana-Mega Prep Sterile Humus / Seed Trt. | 5643 | 74 | 1813 |
| Lipha Tech-Lift / Liguid Infurrow (13 oz/ac) | 5823 | 73 | 1827 |
| Lipha Tech @Peanut Special / Seed Trt. | 5757 | 73 | 1816 |
| Rhizoflo (5 lb/ac) + Nitrogen @ 103 DAP / (50 lb/ac) | 5397 | 72 | 1675 |
| Rhizoflo (5 lb/ac) + Nitrogen @ 103 DAP / (100 lb/ac) | 5331 | 71 | 1639 |
| **LSD 0.05** | **ns** | **ns** | **ns** |

[1] % TSMK = % Total Sound Mature Kernels

Planting Date @ April 27, 2000
Variety @ Tamrun 96
Nitrogen (34-0-0) @ August 9, 2000
Digging Date @ October 5, 2000
Growing Season @ 161 Days
Average Yield @ 5525 lb/ac; Untreated 5242 lb/ac; Treated 5565 lb/ac (300 # Increase)

**Table 8. Seeding rate test, 2000.**
Phillip and Matt Muller Farms, Jackson County

| *Treatment* | *Yield (lb/ac)* | *Grade (%TSMK)*[1] | *Gross return ($/ac)* |
|---|---|---|---|
| 80 lb/ac | 5404 | 72 | 1679 |
| 90 lb/ac | 5508 | 73 | 1735 |
| 100 lb/ac | 5389 | 73 | 1693 |
| **LSD 0.05** | **ns** | **ns** | **ns** |

[1] % TSMK = % Total Sound Mature Kernels

Planting Date @ April 27, 2000
Variety @ Tamrun 96
Digging Date @ October 5, 2000
Growing Season @ 161 Days
Average Yield @ 5434 lb/ac

A second inoculation test was conducted on new peanut land in Jackson County. Yields were not statistically different for the inoculation treatments. However, in all but one case, yields for inoculation treatments were numerically higher than the untreated check. Grades were not affected by the treatments.

Two late season nitrogen fertilizer treatments (50 and 100 lb/ac of actual N) were included at each location. Neither treatment affected peanut pod yields or quality.

## Seeding rate test

Growers frequently plant excessive seed in an attempt to increase pod yields. A seeding rate demonstration was conducted to show that there is little or no difference in yield results from varying seeding rates as long as an adequate amount of seed is planted. Previous research has indicated that seeding rates of 80 lb/ac will produce yields equal to yields from 90-100 lb/ac seedings. The results of this applied research confirmed what had been previously determined.

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# Field studies for the control of peanut diseases

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**2000 progress made possible through OPC support**

- **The benefits of fungicides and resistant varieties for control of Sclerotinia blight were below those observed in previous years because of the low disease pressure in 2000.**
- **While registered fungicides provided good control of southern blight in 2000, spray programs generally were not profitable due to the low disease pressure.**
- **The experimental fungicide BAS 500, which has provided outstanding control of early leaf spot, was also effective against southern blight.**
- **The fungicide Omega, developed for control of Sclerotinia blight, also provided good control of southern blight under moderate disease pressure in 2000.**
- **In Hughes County where leaf spot was severe and digging was delayed by wet weather following the freeze on October 9, fungicide programs dramatically increased yields. The observed response was greatest for varieties with strong pegs such as Tamrun 96 and Tamspan 90.**
- **In southwestern Oklahoma where disease pressure was low and yields were high, fungicide programs were not profitable. In addition, disease-susceptible runner varieties performed better than Tamrun 96, which has moderate disease resistance.**

Sixteen field trials were completed in 2000 that addressed the major peanut diseases faced by growers. The management strategies under evaluation were included chemical control, disease resistant varieties, and biological control. Efforts were made to develop and demonstrate a range of input levels for the disease management programs. The diseases studied included early leaf spot, pepper spot, southern blight, Sclerotinia blight, limb rot, and pod rot. Excellent cooperation in these studies was provided by Ron Sholar and Jerald Nickels, Department of Plant and Soil Sciences; Phil Mulder, Department of Entomology and Plant Pathology; and Hassan Melouk, USDA/ARS at Stillwater. Appreciation is expressed to Gary Weger (Bryan County), Wendell Black and Greg Turpin (Hughes County), and Matt Meuller (Jackson County). These growers provided time and resources as on-farm cooperators for some of the trials. The Samuel Roberts Noble Foundation also is acknowledged for its cooperation and resources provided at the Red River Farm.

The studies on disease management in 2000 served several purposes. The first purpose was to identify new and better ways of managing diseases. The second was to use the trials sites as demonstrations to show growers firsthand the benefits of disease management in peanut production. Trial sites in Bryan, Caddo, Jackson, and Hughes counties were showcased during annual fall field tours. The third purpose was to use the results to support applications for emergency (Section 18) use of fungicides. The results are summarized in this report. In interpreting the results, small differences in treatment values should not be overemphasized. Least significant differences (LSD) values are shown at the bottom of most tables. Unless two values differ by at least the LSD shown (or are not followed by the same letter where the letter notation is used), little confidence can be placed in the superiority of one treatment or variety over another.

Weather conditions did not favor the severe development of diseases in 2000. In June, rain was near or above normal and temperatures below normal in many areas of the state. Sclerotinia blight and leaf spots made an early appearance in June. However, excessive heat and drought became entrenched in late July through mid-September. These adverse conditions limited disease and crop development. An early freeze terminated the crop on October 9 and prevented the typical late-season development of Sclerotinia blight. Finally, rain set in and delayed harvest. Plots in Hughes County were particularly affected by the wet conditions after the freeze that deteriorated the crop. As a result of the adverse conditions, yields were 25 percent to 30 percent below normal at most locations and disease management programs often were not profitable. Therefore, results in 2000 should be interpreted accordingly.

## Sclerotinia blight

Sclerotinia blight remains a destructive disease in Oklahoma. It is prevalent in all areas of the state except in the new production region in far southwestern Oklahoma. The trials focused on fungicide evaluations and determining the response of specific varieties to fungicide treatment. Using data generated by these and past studies, Section 18 applications for the fungicides Botran and Omega (fluazinam) were written and submitted to the Oklahoma Department of Agriculture. EPA approved the requests for Botran and Omega for use in 2000.

At the Caddo Research Station, fungicide treatments applied to the susceptible variety Okrun were compared to untreated runner varieties and Tamspan 90, a resistant Spanish variety. Runner varieties included Tamrun 96 and Tamrun 98, which have shown moderate resistance and improved yields where Sclerotinia blight is a problem. Fungicide treatments included the registered fungicide Rovral; Omega (fluazinam) and Botran, which have been approved for use through the Section 18 in 2000; and an experimental formulation of Topsin.

All fungicide treatments except Topsin 5G reduced the level of Sclerotinia blight on Okrun. (See Table 1.) Spray programs with Omega and Botran at 4 lb/ac provided the best disease control of the fungicide treatments. Rovral, Omega at 1.5 pt/ac, and Topsin also increased yield of Okrun compared to the check. Other fungicide treatments did not significantly increase yield. The significant yield increase for the Topsin treatment was surprising since the level of disease was similar to the check. Omega at 1.5 pt/ac provided the greatest yield increase, about 800 lb/ac. For varieties that did not receive fungicide for Sclerotinia blight, Tamspan 90 and Tamrun 98 showed the best disease resistance. Tamrun 96 was moderately resistant, having 50 percent less disease than Okrun. However, Tamrun 96 was the only variety that yielded significantly higher than the Okrun check. The 385 lb/ac yield increase for Tamrun 96 was much lower than in previous years. Despite having the lowest level of disease in the trial, Tamspan 90 also yielded the lowest, over 700 lb/ac below the Okrun check, which yielded more than 3200 lb/ac. Yields for Okrun not treated with fungicide for Sclerotinia blight are normally in the range of 1500 to 2000 lb/ac in this field. Grades ranged from 65 for Tamrun 96 and Tamspan 90 to 72 for Okrun treated with Omega. Economic returns were most favorable for Omega at 1.5 pt/ac and for Tamrun 96 and Tamrun 98. Increases in economic returns over the Okrun check ranged from $191/ac for Omega at 1.5 pt/ac to $54/ac for Tamrun 98. Other fungicide programs and varieties had lower economic return compared to the Okrun check. Because disease levels were below normal, benefits from fungicide programs and resistant varieties were below those observed in previous years.

Work continued for a third year with a new experimental fungicide in an adjacent trial. Performance of this fungicide, whose identity cannot be disclosed because of a secrecy agreement signed with its developer, has been similar to that of Omega. While disease pressure was lower compared to 1999, performance of the fungicide in 2000 was again similar to Omega.

Promising runner varieties were grown with and without fungicide treatment for Sclerotinia blight at the Caddo Research Station in 2000. Varieties included Tamrun 96, Tamrun 98, Georgia Green, ViruGard, and AT-120. Tamrun 98 has the best resistance of the runner varieties while Tamrun 96 is moderately resistant. Georgia Green also has shown some moderate resistance. ViruGard has not been beneficial for Sclerotinia blight, but it was included again because growers have reported positive results with this variety. AT-120 was included because it is a popular, early-maturing variety. These were compared to Okrun, a susceptible runner variety, and Tamspan 90, a resistant Spanish variety. Plots of each entry were left un-

**Table 1. Control of Sclerotinia blight with fungicides or resistant varieties at the Caddo Research Station, 2000.**

| *Treatment & rate/ac (no. applications)* | *Sclerotinia blight (%)* | *Yield (lb/ac)* | *Grade (%TSMK)* | *Value ($/ac)* | *Cost ($/ac)* [1] | *Return ($/ac)* [2] |
|---|---|---|---|---|---|---|
| Rovral 4F 1 qt (3) [3] | 14 | 3601 | 71 | 1105 | 138 | 967 |
| Botran 75W 2 lb (5) [3] | 14 | 3354 | 68 | 990 | 117 | 873 |
| Botran 75W 4 lb (2) [3] | 8 | 3354 | 69 | 1009 | 87 | 922 |
| Topsin 5G 28 lb (4) [3] | 30 | 3601 | 67 | 1051 | ? | ? |
| Omega 4F 1.5 pt (2) [3] | 10 | 4095 | 72 | 1282 | 126 | 1156 |
| Omega 4F 1.0 pt (3) [3] | 3 | 3499 | 71 | 1078 | 129 | 949 |
| Tamspan 90 | 0 | 2468 | 65 | 704 | 0 | 704 |
| Tamrun 96 | 16 | 3616 | 65 | 1028 | 0 | 1028 |
| Tamrun 98 | 8 | 3296 | 71 | 1019 | 0 | 1019 |
| Okrun | 38 | 3231 | 69 | 965 | 0 | 965 |
| LSD (P=0.05) [4] | 15 | 304 | | | | |

1 Treatment cost = cost of fungicides for Sclerotinia blight ($43.10/qt Rovral, 10.18/lb Botran, $40/pt Omega) + $3.00/spray for application costs.
2 Partial return = (crop value) - (treatment cost).
3 Treatments applied to Okrun.
4 Least significant difference.

treated, or received spray programs with Rovral 4F (3 appl. @ 1 qt/ac), Botran 75W (2 appl. @ 4 lb/ac), a low level of Omega 4F (1 appl. @ 2 pt/ac), and a high level of Omega 4F (2 appl. @ 1.5 pt/ac).

Levels of Sclerotinia blight were low (30 percent or less) in this trial. Generally, all fungicide programs reduced levels of disease on the more susceptible varieties Okrun, ViruGard, AT-120, and Georgia Green. Disease levels were low on the other varieties and spray programs could not be differentiated. None of the spray programs increased yields for any of the varieties. Therefore, only the results of the untreated check plots are presented. (See Table 2.) Tamspan 90, Tamrun 98, and Tamrun 96 had less than 10 percent disease and showed the best resistance. Okrun had the highest level of disease, while disease was intermediate for the other varieties. Tamrun 96 was the highest yielding variety while Tamspan 90 was the lowest. Yields for the other varieties were similar, ranging from 3400 to 3800 lb/ac. Yields for the most susceptible varieties (Okrun and AT-120) were above 3400 lb/ac, well above those in previous trials at this site. Grades were variable among varieties. ViruGard had the highest grade while that of AT-120 was 10 points lower. Crop values were over $1000/ac for all varieties except Tamspan 90 and AT-120.

The benefits of spray programs and resistant varieties were less than those previous observed because of the low disease pressure in this trial. This was most evident by the relatively high yield and crop value of the Okrun check. Because of the high costs of the fungicide programs, which ranged from $83/ac for the reduced Omega program to $138/ac for the Rovral program, none of the spray programs were profitable in this trial.

Two biological fungicides were evaluated on the susceptible variety Okrun at the Caddo Research Station. In one trial, Contans, a fungus that is reported to parasitize and kill sclerotia of *Sclerotinia minor* in soil, was incorporated into the soil at 1.8 and 3.6 lb/ac prior to planting. The Contans treatments were compared to a spray program with the fungicide Omega and an untreated check. Disease pressure was very low (10 percent or less) in this study and differences between treatments were not evident. In a second study, a formulation of bacteria that has shown activity

**Table 2. Yield and disease responses of peanut varieties not treated with fungicide for control of Sclerotinia blight at the Caddo Research Station, 2000.**

| *Variety* | *Sclerotinia blight (%)* | *Yield (lb/ac)* | *Grade (%TSMK)* | *Value ($/ac)* |
|---|---|---|---|---|
| Okrun | 32 | 3637 | 68 | 1071 |
| Tamspan 90 | 0 | 2912 | 69 | 867 |
| Tamrun 96 | 6 | 4504 | 68 | 1325 |
| Tamrun 98 | 8 | 3839 | 73 | 1219 |
| Georgia Green | 28 | 3446 | 70 | 1053 |
| AT-120 | 25 | 3476 | 65 | 989 |
| ViruGard | 20 | 3839 | 75 | 1241 |
| LSD (P=0.05) [1] | 16 | 411 | | |

[1] Least significant difference at P=0.05.

against *Sclerotinia minor* in culture was tested using different methods of application in comparison to fungicide programs and an untreated check. The level of disease in the untreated check was about 30 percent and the fungicide Omega was the only treatment that significantly reduced disease. As a result of the low disease pressure, yields in this study also did not differ among treatments.

## Southern Blight

Southern blight is another damaging soil-borne disease that is a problem statewide. Effective management of southern blight relies on the use of fungicides because varieties with resistance are not locally adapted and long crop rotations often are not feasible. Folicur, Abound, and Moncut have provided good to excellent disease control in fields with a history of southern blight. Folicur and Abound also are effective against foliar diseases. Moncut has been marketed alone and with Bravo (Bravo/Moncut) or with Tilt (Montero) to provide control of foliar diseases. In 2000, trials focused on comparing the performance and profitability of spray programs using registered and new fungicides under development.

Five trials were completed in Bryan

**Table 3. Evaluation of BAS 500 for control of southern blight on "Okrun" in Bryan County, 2000.**

| *Treatment and rate/ac (timing [1])* | *Southern blight (%)* | *Yield (lb/ac)* | *Grade (%TSMK)* | *Value ($/ac)* | *cost [2] ($/ac)* | *Return [3] ($/ac)* |
|---|---|---|---|---|---|---|
| Bravo WS 6F 1.5 pt (1-6) | 28 | 2441 | 71 | 754 | 75 | 679 |
| Bravo WS 6F 1.5 pt (1,6)<br>BAS 500 2.1F 12.2 fl oz (2-5) | 11 | 3004 | 70 | 908 | ? | |
| Bravo WS 6F 1.5 pt (1,6)<br>BAS 500 2.1F 15.3 fl oz (2-5) | 14 | 2586 | 73 | 818 | ? | |
| Bravo WS 6F 1.5 pt (1,6)<br>Folicur 3.6F 7.2 fl oz (2-5) | 14 | 3140 | 76 | 1027 | 104 | 923 |
| Bravo WS 6F 1.5 pt (1,3,5,6)<br>Abound 2.1F 18.5 fl oz (3,5) | 11 | 3331 | 72 | 1043 | 123 | 920 |
| Bravo WS 6F 1.5 pt (1-6)<br>Moncut 50W 1.2 lb (3,5) | 13 | 2568 | 71 | 790 | 118 | 672 |
| check | 33 | 2305 | 69 | 695 | 0 | 695 |
| LSD (P=0.05) [1] | 14 | NS | | | | |

[1] All spray programs received six sprays (1-6) on a 14-day schedule beginning 45 days after planting.
[2] Cost based on $6.31/pt for Bravo, $2.33/fl oz for Folicur, $1.83/fl oz for Abound, and $18.14/lb Moncut, and $3.00/spray for application costs.
[3] Partial return = (crop value) - (treatment cost).
[4] Least significant difference; NS= treatment effect not significant at P=0.05.

County in a field with a history of southern blight. In one study, all of the registered products were compared with the new experimental fungicide BAS 500, which is in the same fungicide class as Abound (strobilurin) and has provided outstanding control of early leaf spot in previous trials. A second study focused on use of Montero, a twin pack of Tilt and Moncut. Various timings and numbers of applications were applied in comparison to standard Folicur and Abound programs. In a third study, Moncut, which is now available as a stand-alone product at a lower price ($18/lb) was applied at various rates in comparison to Folicur and Abound. In a fourth study, various spray programs with Abound and Omega were evaluated in comparison to Folicur and Bravo alone. In a fifth trial, Stratego, a mixture of Tilt and Flint (strobilurin) primarily developed for foliar disease control, was used in various spray programs with Moncut and Abound.

Disease pressure was spotty at this site in 2000; some trials had significant levels of disease while others did not. Southern blight first appeared about September 1. Due to the severe drought conditions in this region, leaf spot did not develop. Disease levels were greatest in the trial with BAS 500. (See Table 3.) All fungicide programs provided at least a 50 percent reduction in disease compared to Bravo alone and the untreated check. Performance of BAS 500 in a block spray program at 12.2 and 15.3 fl oz/ac was similar to spray programs with Folicur, Abound, and Moncut. Yields were highly variable in this study and were not significantly different among treatments.

Disease pressure was not sufficient to affect yields in the other trials, but a few conclusions could be drawn. Moncut programs yielded better in the other trials compared to the BAS 500 study. Omega, a fungicide developed for Sclerotinia blight, provided good control of southern blight and was similar in performance to Abound and Folicur. Finally, spray programs in many of the trials were not profitable due to the low disease pressure and high costs of the spray programs.

## Limb rot

The soil-borne fungus Rhizoctonia causes limb rot. The fungus causes peg, pod, and stem rots. This disease is most important on sandy soils where runner varieties are grown under a high level of management. The disease often is not apparent until after the peanuts are dug. At the Noble Foundation Red River Farm, limb rot has become an increasingly important problem. Aside from avoiding rotations with cotton, which aggravates the disease, crop rotation is not very effective in controlling this disease because the fungus has a wide host range. Fungicides that control southern blight such as Folicur, Moncut, and Abound are effective against limb rot. However, the responses of specific varieties to the disease and to fungicide programs are not well defined.

In the third year of this study, spray programs consisted of four-spray and two-spray block programs with Folicur, a four-spray block program with Bravo/Moncut, and two-spray programs of Abound at 60 and 90 days after planting at 12.3 and 18.5 fl oz/ac. The check treatment was a full-season Bravo program for leaf spot. Varieties included Tamrun 96 and Tamspan 90 which have been moderately resistant to limb rot in previous trials; and ViruGard, Okrun, Georgia Green, and Tamrun 98 which have been susceptible.

In 2000, limb rot pressure was lower than in 1998 and 1999 when up to 50 percent of the check plots were diseased. Disease severity was low as infections were mostly evident on the branch tips and foliage in contact with the soil. None of the spray programs reduced levels of disease compared to the check treatment. Tamspan 90 had the lowest levels of limb rot (less than 10 percent) while ViruGard had the highest (over 60 percent). However, pod loss at harvest, apparently due to over-maturity, was severe for ViruGard. Thus, the limb rot ratings were probably inflated on this variety. Levels of limb rot averaged from 14 percent to 18 percent on the other varieties. Spray programs did not increase yields, which ranged from 3141 to 3482 lb/ac when averaged over varieties. However, significant differences in yield were apparent among varieties. Averaged over spray programs, Georgia Green (4125 lb/ac) and Tamrun 96 (3973 lb/ac) had the highest yields while ViruGard (1720 lb/ac) and Tamspan 90 (2928 lb/ac) had the lowest yields. Grades were lower than previous trials at this site, ranging from 62 for Tamrun 98 to 68 for Georgia Green. Crop value was highest for Georgia Green ($1215/ac), Tamrun 96 ($1101/ac), and Okrun ($1056/ac). Spray programs were not profitable in this study compared to the check treatment.

## Foliar diseases

Foliar diseases are widespread across all production areas of Oklahoma and can be damaging when severe. Where early leaf spot is not controlled, yield losses have averaged from 500 to 700 lb/ac. However, losses exceeding 1,000 lb/ac are possible in years when weather patterns favor severe disease development. Pepper spot is a foliar disease that has increased in prevalence in recent years, particularly on runner varieties. However, the damage potential of this disease and effective treatments for its control have not been identified.

Two trials on foliar disease control were completed in 2000. Fungicides were compared for control of early leaf spot on Tamspan 90 at the Agronomy Research Farm at Perkins. At the Caddo Research Station, fungicides were compared for control of pepper spot on Tamspan 90 and on the susceptible runner variety ViruGard. Hot and dry conditions limited disease development; however, differences in levels of disease were apparent. (See Table 4.)

Levels of early leaf spot reached 62 percent in the untreated check plots. All fungicide programs except Dithane reduced leaf spot compared to the check. Spray programs that provided the best control included the Folicur block program, the Topsin/Bravo program, Tilt/Bravo programs, and the two block programs with BAS 500 at 6.1 and 9.2 fl oz/ac. Control of early leaf spot with two applications of Tilt/Bravo according to the MESONET early leaf spot advisory program was similar to the best treatments that utilized six sprays. Performances of the Bravo and Equus formulations of chlorothalonil were similar. The spray program with Abound was less effective than in previous trials. Defoliation was less than 50 percent for all treatments. As a result of the low disease pressure, there were no statistical differences among yields which ranged from 1900 to 2600 lb/ac. Yield for the untreated check was 2454 lb/ac. Therefore, none of the spray programs was profitable in this study.

At the Caddo Research Station, levels of pepper spot in the untreated check plots reached 50 percent for Tamspan 90 and 62 percent for ViruGard. On Tamspan 90, all spray programs reduced pepper spot compared to the check and performed similarly. However, none of the treatments reduced pepper levels of pepper spot on ViruGard. Defoliation was low (less than 5 percent) on Tamspan 90 and was below 50 percent for ViruGard. Therefore, yields did not statistically differ among treatments for either variety. Yields of Tamspan 90 ranged from 2737 to 3282 lb/ac while yields of Virugard ranged from 3470 to 3891 lb/ac. As a result of the low to moderate disease pressure, none of the spray programs was profitable.

Spray programs for control of foliar diseases, southern blight, and limb rot were evaluated on different peanut cultivars in Hughes County in 2000. Soil-borne disease

**Table 4. Control of early leaf spot in Payne County and pepper spot at the Caddo Research Station, 2000.**

| *Treatment and rate/ac (timing [1])* | *Early leaf spot (%)* | *Pepper spot (%)* | |
|---|---|---|---|
| | *Tamspan 90* | *Tamspan 90* | *ViruGard [2]* |
| Bravo WS 6F 1.5 pt (1-6) | 20 | 11 | 41 |
| Bravo Ultrex 82.5DF 1.4 lb (1-6) | 12 | 22 | 50 |
| Tilt 3.6E 2 fl oz + Bravo 720 1 pt (1-6) | 4 | 14 | 56 |
| Tilt 3.6E 2 fl oz + Bravo 720 1 pt (advisory) | 9 | | |
| Bravo 720 1 pt (1,6) Tilt 3.6E 4 fl oz (2-4) | 6 | 7 | 70 |
| Equus 720 1.5 pt (1-6) | 16 | 11 | 70 |
| Equus 82.5DF 1.4 lb (1-6) | 24 | 7 | 51 |
| Dithane RS NT 75DF 2 lb (1-6) | 50 | 17 | 44 |
| Bravo WS 6F 1.5 pt (1,6) Folicur 3.6F 7.2 fl oz (2-5) | 3 | 22 | 75 |
| Bravo WS 6F 1.5 pt (1,3,5,6) Abound 2.1F 18.5 fl oz (2,4) | 40 | 14 | 35 |
| Topsin M 70W 0.5 lb + Bravo WS 6F 0.75 pt (1,3,5) Bravo WS 6F 1.5 pt (2,4,6) | 5 | 2 | 40 |
| Bravo WS 6F 1.5 pt (1,6) BAS 500 2.1F 6.1 fl oz (2-5) | 2 | 4 | 59 |
| Bravo WS 6F 1.5 pt (1,6) BAS 500 2.1F 9.2 fl oz (2-5) | 1 | 12 | 68 |
| Stratego 2.1E 7 fl oz (1,3,4) Bravo WS 6F 1.5 pt (5) | 16 | 21 | 66 |
| check | 62 | 50 | 62 |
| LSD (P=0.05) [2] | 16 | 17 | NS |

[1] Spray numbers 1 - 6 correspond to six sprays applied on a 14-day schedule beginning 30 June for early leaf spot at Perkins, and beginning 6 July for pepper spot at the Caddo Research Station. Advisory= two applications were made (30 June, and 25 July) according to the MESONET early leaf spot advisory.
[2] Least significant difference; NS= treatment effect not significant at P=0.05.

did not develop at this location. However, conditions were favorable for early leaf spot during June and July. During the drought period in August and September, plots received frequent irrigations that apparently created a favorable microclimate for further increase in leaf spot. Therefore, the trial became a good foliar disease study. Following the freeze on October 9, rainy weather delayed harvest until November 17 when the vines had seriously deteriorated. Spray programs and varieties had large impacts on resulting levels of disease and yield. (See Table 5.)

Leaf spot reached levels of 76 percent to 90 percent in untreated check plots by mid-September. All spray programs provided excellent control of leaf spot on the runner varieties. However, disease levels were higher in treated plots of Tamspan 90. Averaged over varieties, the Abound program was less effective than the other fungicide programs.

Yields were low for plots of all varieties that were not sprayed with fungicide. Yield in the check plots ranged from 0 lb/ac for AT-120 and 1026 lb/ac for Tamrun 96. Spray programs increased yields of all varieties compared to the check. However, yields still remained low (less than 2000 lb/ac) for treated plots of AT-120, Okrun, ViruGard. These varieties apparently have weaker pegs compared with Tamrun 96, Tamrun 98, Georgia Green, and Tamspan 90. Yields were highest for Tamrun 96, which had yields greater than 3300 lb/ac for all spray programs. Treated plots of Georgia Green and Tamspan 98 also yielded well despite the adverse conditions. Because of the low yield in unsprayed plots, all spray programs were profitable at this location. Gross value was increased by $250 to $900 per acre over the untreated control, thus offsetting the costs of the programs that ranged from $75 to $125 per acre.

## Pod rot

Pod rot is a serious problem in isolated fields in Oklahoma each year. *Pythium* and *Rhicoctonia* are two fungi that cause pod rot. Both fungi are usually involved where pod rot is severe. In 2000, two trials were completed in a field with a history of severe pod rot located in Hughes County. In the first trial, the reaction of commonly grown peanut varieties was evaluated. In another study, various fungicide programs were evaluated on the susceptible variety AT-120. Fungicides evaluated included Ridomil, Abound, Folicur, Moncut, and BAS 500.

Pod rot reached moderate levels in 2000. In the variety trial, NC-7, AT-120, Jupiter, Okrun, and ViruGard had the highest levels of pod rot. Georgia Green, Tamrun 98, and Tamspan 90 had the lowest levels of pod rot. Florunner and Tamrun 96 were intermediate. These results differed from those in previous trial when 1) Jupiter had less pod rot than NC-7, 2) Tamrun 96 was among the most resistant entries, and 3) Okrun had less pod rot than Florunner. Tamspan 90 consistently remained among the most resistant varieties to pod rot. In the fungicide study on the susceptible variety AT-120, disease was variable and none of the treatments resulted in significant reductions in pod rot compared to the untreated check. Yields at this location could not be determined because the site remained too wet to dig.

## Disease management in southwestern Oklahoma

Peanut production is increasing in far southwestern Oklahoma. Growers in this part of the state have not experienced severe losses to disease because of low rainfall and humidity, and soils that do not have a long history of peanut production. However, foliar diseases, southern blight, limb rot, and pod rot have been identified as

## Table 5. Disease and yield responses of peanut varieties to fungicide spray programs for control of soil-borne and foliar diseases in Hughes County, 2000.

| *Treatment and rate/A (timing [1])* | *AT-120* | *Georgia Green* | *Okrun* | *Tamrun 96* | *Tamrun 98* | *Tamspan 90* | *ViruGard* | *mean[2]* |
|---|---|---|---|---|---|---|---|---|
| Leaf spot (%) - 21 Sept. | | | | | | | | |
| Bravo WS 6F 1.5 pt (1,6)<br>Folicur 3.6F 7.2 fl oz (2-5) | 6 | 4 | 4 | 4 | 4 | 28 | 7 | 8 c |
| Bravo WS 6F 1.5 pt (1-6)<br>Moncut 50W 1.5 lb (2,4) | 6 | 3 | 3 | 4 | 4 | 20 | 4 | 6 c |
| Tilt/Bravo 10 fl oz (1-6)<br>Tilt 3.6E 4 fl oz +<br>Moncut 50W 1.5 lb (2-4) | 10 | 7 | 5 | 4 | 4 | 27 | 5 | 9 c |
| Bravo WS 6F 1.5 pt (1,3,5,6)<br>Abound 2.1F 18.5 fl oz (2,4) | 10 | 9 | 11 | 7 | 7 | 43 | 4 | 13 b |
| check | 88 | 78 | 81 | 82 | 78 | 90 | 76 | 82 a |
| Mean [3] | 24 b | 20 bc | 21 bc | 20 bc | 19 c | 42 a | 19 c | |
| Yield (lb/ac) | | | | | | | | |
| Bravo WS 6F 1.5 pt (1,6)<br>Folicur 3.6F 7.2 fl oz (2-5) | 653 | 2741 | 1688 | 3331 | 2287 | 2559 | 1543 | 2114 |
| Bravo WS 6F 1.5 pt (1-6)<br>Moncut 50W 1.5 lb (2,4) | 381 | 2233 | 1370 | 3458 | 1779 | 2367 | 1352 | 1848 |
| Tilt/Bravo 10 fl oz (1-6)<br>Tilt 3.6E 4 fl oz +<br>Moncut 50W 1.5 lb (2-4) | 427 | 2641 | 1788 | 3476 | 2441 | 2614 | 1334 | 2103 |
| Bravo WS 6F 1.5 pt (1,3,5,6)<br>Abound 2.1F 18.5 fl oz (2,4) | 744 | 2913 | 2042 | 3893 | 2605 | 2741 | 1833 | 2396 |
| check | 0 | 381 | 127 | 1026 | 499 | 581 | 617 | 461 |
| Mean | 441 | 2182 | 1403 | 3037 | 1922 | 2173 | 1336 | |
| LSD (P=0.05)[4] | 226 | 768 | 443 | 528 | 473 | 496 | 420 | |

[1] Spray numbers 1 to 6 correspond to the six sprays applied on a 14-day schedule beginning 3 July.
[2] Mean values in a column followed by the same letter are not statistically different at P=0.05.
[3] Mean values in a row followed by the same letter are not statistically different at P=0.05.
[4] Least significant difference among yields within a variety.

potentially damaging diseases in this new peanut area.

In 2000, a trial was completed in Jackson County in a field that had been cropped to peanuts for the first time in 1999. Because high disease pressure was not anticipated, reduced-input spray programs were evaluated on the three most commonly grown varieties in the area. Varieties included Tamrun 96, which has moderate resistance to several soil-borne diseases, and AT-120 and Okrun, which are susceptible to most soil-borne diseases. Fungicide programs consisted of one or two applications, targeted at either foliar disease (Bravo, Tilt, Tilt/Bravo), soil-borne disease (Moncut), or both (Abound, Folicur).

Despite the short peanut history, early leaf spot, southern blight, and limb rot occurred in the plots. Levels of southern blight were so low (less than 5 percent) that differences among spray programs and varieties could not be distinguished. Leaf spot reached a moderate level of 66 percent by digging. The amount of leaf spot was surprising because of the extended periods of hot, dry weather at this location from July through September. Apparently the furrow irrigation at this site created a favorable microclimate for infection. All of the spray programs had statistically lower levels of

**Table 6. Effect of spray programs on control of foliar and soil-borne disease of peanut varieties in Jackson County, 2000.**

| Treatment and rate/ac (timing [1]) | *Early leaf spot (%)* | | | | *Limb rot (%)* | | | |
|---|---|---|---|---|---|---|---|---|
| | *AT-120* | *Okrun* | *T-96* | *Mean* | *AT-120* | *Okrun* | *T-96* | *Mean* |
| Bravo WS 6F 1.5 pt (1,2) | 1 | 1 | 1 | 1 | 15 | 21 | 2 | 12 |
| Folicur 3.6F 7.2 fl oz (1,2) | 2 | 1 | 1 | 1 | 7 | 7 | 1 | 5 |
| Tilt 3.6E 4 fl oz + Moncut 50W 1.2 lb (1,2) | 2 | 2 | 5 | 3 | 27 | 15 | 2 | 15 |
| Tilt 3.6E 4 fl oz + Moncut 50W 2.0 lb (1) | 4 | 2 | 2 | 3 | 14 | 10 | 1 | 8 |
| Abound 2.1F 18.5 fl oz (1) | 16 | 5 | 20 | 14 | 9 | 5 | 5 | 6 |
| Abound 2.1F 18.5 fl oz (1,2) | 19 | 14 | 3 | 12 | 8 | 12 | 1 | 7 |
| Tilt/Bravo 10 fl oz (adv.) | 56 | 36 | 36 | 43 | 16 | 14 | 1 | 10 |
| Check | 79 | 56 | 62 | 66 | 18 | 15 | 2 | 12 |
| Mean [2] | 22 a | 14 b | 16 ab | | | | | |
| LSD (P=0.05) [3] | | | | 10 | | | | NS |

[1] Spray numbers 1 to 2 correspond to the two sprays applied on 19 July and 9 Aug. Adv.= sprays applied according to the MESONET early leaf spot advisory program. One spray was applied for the advisory program on 30 June.
[2] Mean values in a row followed by the same letter are not significantly different at P=0.05.
[3] LSD = Least significant difference between treatments; NS=treatment effect not significant at P=0.05.

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**Table 7. Effect of spray programs on yield and value of peanut varieties in Jackson County, 2000.**

| *Treatment and rate/ac (timing [1])* | *Yield (lb/ac)* | | | | *Value ($/ac)* | | | |
|---|---|---|---|---|---|---|---|---|
| | *AT-120* | *Okrun* | *T-96* | *Mean* | *AT-120* | *Okrun* | *T-96* | *Mean* |
| Bravo WS 6F 1.5 pt (1,2) | 5391 | 6093 | 5285 | 5589 | 1704 | 1973 | 1635 | 1771 |
| Folicur 3.6F 7.2 fl oz (1-2) | 6191 | 6387 | 5286 | 5949 | 1963 | 2119 | 1652 | 1911 |
| Tilt 3.6E 4 fl oz + Moncut 50W 1.2 lb (1-2) | 5979 | 5995 | 5407 | 5794 | 1868 | 1953 | 1745 | 1855 |
| Tilt 3.6E 4 fl oz + Moncut 50W 2.0 lb (1) | 5962 | 6044 | 5325 | 5777 | 1844 | 1966 | 1650 | 1820 |
| Abound 2.1F 18.5 fl oz (1) | 5685 | 5366 | 5105 | 5385 | 1805 | 1714 | 1595 | 1705 |
| Abound 2.1F 18.5 fl oz (1,2) | 6297 | 6322 | 5489 | 6036 | 1954 | 1968 | 1769 | 1897 |
| Tilt/Bravo 10 fl oz (adv.) | 6036 | 5921 | 4941 | 5633 | 1881 | 1871 | 1524 | 1759 |
| Check | 5407 | 5832 | 5399 | 5546 | 1691 | 1896 | 1675 | 1754 |
| Mean [2] | 5868a | 5995a | 5277b | | 1839 | 1933 | 1656 | |
| LSD (P=0.05) [3] | | | | NS | | | | |

[1] Spray numbers 1 to 2 correspond to the two sprays applied on 19 July and 9 Aug. Adv.= sprays applied according to the MESONET early leaf spot advisory program. One spray was applied for the advisory program on 30 June.
[2] Mean values in a row followed by the same letter are not significantly different at P=0.05.
[3] LSD = Least significant difference between treatments; NS=treatment effect not significant at P=0.05.

leaf spot compared to the unsprayed check. (See Table 6.) All spray programs provided excellent leaf spot control except for Tilt/Bravo applied according to the MESONET advisory program. The advisory program only triggered one spray in June. However, defoliation in the check plots was below 50 percent, not sufficient to influence yields. Among varieties, Okrun had the lowest levels of leaf spot. Levels of limb rot also were low and did not differ among spray programs. (See Table 6.) However, Tamrun 96 had significantly less limb rot than AT-120 or Okrun.

Yields were high at his location and exceeded 5000 lb/ac in unsprayed plots. Because of the low disease pressure, none of the spray programs statistically increased yields compared to check plots. However, varieties differed in yield. AT-120 and Okrun produced significantly higher yields than Tamrun 96. This differed from previous trials in other areas of the state where disease pressure is higher and Tamrun 96 has performed better than other runner varieties. Grades ranged from 72 to 75 at this location which, together with the high yields, resulted in high values per acre for all varieties and spray programs.

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