IPM in Peanuts: Developing and Delivering Working IPM Systems

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Peanuts are managed intensively because of the crop's high value and vulnerability to diseases, insects, and weeds. Crop protection chemicals have a central role in pest management strategies for peanut production (5,10), and this role has been perpetuated by the absence of effective alternatives. Currently, some 30 pesticides are available for control of diseases, insects, and weeds in commercial peanut fields. The acute toxicity of these chemicals varies widely (3); acute oral LD_{50} levels range from 0.93 to >10,000 mg/kg in white rats.

The kinds and amounts of pesticides applied to peanuts annually can vary from field to field depending on pest problems and seasonal variations in weather conditions. Over the last decade, fungicides and herbicides have accounted for the largest tonnage of pesticide use on peanuts, with inputs ranging from 4.5 to 11 kg a.i./ha for fungicides and 4.5 to 9 kg a.i./ha for herbicides in the Virginia and North Carolina production area (P. M. Phipps, *unpublished*). Inputs of insecticides and nematicides have been estimated to range from 3.4 to 7.8 kg a.i./ha and from 0 to 3.4 kg a.i./ha, respectively.

Decisions to use pesticides are commonly made on the basis of recommendations and services provided by the Cooperative Extension Service. The role of this organization has continued to grow as a result of its increasing involvement in applied research and delivery of new technology. Programs and services that have impacted directly on decisions concerning pesticides include: pest identification clinics, soil testing for nematodes, the peanut leaf spot advisory program, pest alerts, pesticide applicator training and certification, training for crop consultants and scouts, and numerous educational meetings involving short courses, field tours, and on-farm test demonstrations.

The purpose of this report is to describe some of the advances in plant pathology that have had significant impact on reducing the tonnage of nematicides and fungicides used for peanut production in Virginia.

Predictive Nematode Assay Program

Following the recognition of nematode damage in peanuts and the benefits of nematicides in the late 1940s and early 1950s, growers have used these chemicals to prevent nematode damage. Prior to 1981, most growers were routinely applying a nematicide to their entire acreage of peanuts.

In the fall of 1980, the Predictive Nematode Assay Program was established in Virginia to provide an opportunity for growers to identify fields containing hazardous levels of nematodes. Growers then used nematicides or planted nonhost crops where problems might threaten profits from peanut production (7). No charges were assessed for processing samples, and because of the program's rapid acceptance and demonstrated benefit, it was expanded to include other field crops. Beginning in the fall of 1990, it became necessary to charge $11 per sample for counts of vermiform nematodes and $19 for counts of cyst-forming nematodes. These charges resulted in reduced grower utilization of the program for crops planted in 1991. A return to widespread testing of soils seems likely as a result of recognized benefits, coupled with industry-sponsored incentives for growers to again use the program.

Local extension units in each county provide soil sampling kits that include forms, sample bags, and instructions for proper shipment of samples to the Predictive Nematode Assay Laboratory at Virginia Tech. About 6–8 wk after sample submission, growers receive reports on the numbers and kinds of nematodes in each sample and a recommendation if nematode control is needed in the crop to be grown. Threshold populations of various nematodes that might pose a threat to crop production are based on results of more than 15 years of field research in Virginia and North Carolina. These thresholds continue to be tested and adjusted to accommodate changes in nematode populations, crop cultivars, and cropping practices.

Many growers were able to reduce their use of nematicides by as much as 35% after the predictive nematode assay program was introduced in Virginia. In 1989, the program was estimated to offer a savings of $800,000 in production costs and the application of granular nematicide products by 192 t (about 29 t of active ingredient).

Early Leaf Spot Advisory

Fungicides are necessary for control of early leaf spot of peanut in Virginia and North Carolina because of inadequate disease resistance in commercially acceptable peanut cultivars. Organic fungicides for leaf spot control became available in the early 1970s. Growers routinely applied these fungicides at 10- to 14-day intervals beginning as early as 30–40 days after planting and continuing until 14–21 days prior to harvest. Six or seven fungicide applications became a common practice in a growing season. An application of the fungicide chlorothalonil to Virginia's peanut crop requires about 49 t of active ingredient at a total cost of about $1,050,000.

Early leaf spot of peanut is caused by the fungus *Cercospora arachidicola* S. Hori, which requires warm, humid weather for sporulation and infection in peanuts. Detailed studies have provided precise definitions of the effects of weather conditions on spore germination and growth and have led to the development of computer programs to identify periods of infection (4). Practical use of these programs required an ability to accurately monitor relative humidity and rapidly process these data on a daily basis. This obstacle was overcome in 1979 with the implementation of an environmental monitoring system developed through cooperative research by Virginia

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Tech, the National Aeronautic and Space Administration, and the United States Department of Agriculture. Automated electronic sensors and microprocessors have provided accurate records of weather conditions at 10-min intervals from three locations in the Virginia peanut production area (9). A data collection center at the Tidewater Agricultural Experiment Station in Suffolk automatically retrieves data from each field station. The central computer prints peanut leaf spot advisories for each location at 4 p.m. every day. Once the advisories have been verified, a recorded message is prepared for delivery to producers in the peanut production areas.

Growers obtain the daily leaf spot advisory by listening to local radio stations or by calling a toll-free number from any location in Virginia (6). Early in the growing season, the advisory program alerts growers of the need to make their first application of fungicide. Subsequent advisories report the "last effective spray date" for a fungicide application to still be active against infection. Peanuts sprayed before that date should be considered vulnerable to infection, and the application of a fungicide is recommended. If a spray was applied since "the last effective spray date" in the advisory, then no fungicide is needed. Daily advisories are given for each area surrounding the three weather monitoring stations in Virginia. Growers use the advisory from the weather station nearest their fields. The weather stations are about 30 miles apart, and 85% of the Virginia peanut production area falls within a 15-mile radius of the three locations.

Growers participating in the program have used an average of 2.25 fewer fungicide sprays for leaf spot control per season, in comparison to a conventional 14-day calendar program (4,8) during the period of 1987 through 1990 (Table 1). According to annual estimates of cost for applications of chlorothalonil (1.12 kg/ha), the advisory program reduced input cost an average of 33%, or $57/ha, compared with the 14-day spray schedule. Although levels of early leaf spot are sometimes higher when the advisory program is used instead of a 14-day spray schedule, yields also are frequently higher (4,8). Yield advantages of the advisory program may be due to reduced vine damage and soil compaction by tractor tires and to reduced severity of other problems such as Sclerotinia blight. For an average grower with 50 ha of peanuts, the savings in input costs alone averaged $2,850 per year. Equally important is the reduced tonnage of fungicide applied in the eight-county environment where peanuts are grown. A savings of 2.25 sprays of fungicide on peanuts in Virginia would reduce the quantity of fungicide used by as much as 111 t of active ingredient (chlorothalonil). Results of a grower survey in 1990 indicated that 94% of the peanut growers in Virginia applied foliar fungicides according to the Virginia peanut leaf spot advisory program.

New Fungicide Chemistry

The registration of new fungicide chemistry for control of leaf spot and other diseases of peanuts will substantially reduce the tonnage of fungicides applied in peanut production. In Virginia, tebuconazole, cyproconazole, diniconazole, and propiconazole represent a class of fungicides that inhibit a demethylation step in sterol biosynthesis and provide good to excellent control of early leaf spot at rates as low as 0.126 kg a.i./ha. These materials may reduce the tonnage of fungicides applied in peanut production by more than 90% if they replace the compounds currently in use. In addition to control of early leaf spot, these materials also possess activity against soilborne peanut diseases such as southern stem rot and Rhizoctonia limb rot (2).

Spray Adjuvants

Several spray adjuvants have been tested for improving the efficiency of leaf spot control in peanuts. SoyOil 937 (93% soybean oil and 7% emulsifier) was found to consistently improve the performance of chlorothalonil against early leaf spot (4). Chlorothalonil at 0.95 kg/ha plus SoyOil 937 at 0.5% of spray volume resulted in disease control that was equivalent to the full label rate of chlorothalonil alone at 1.26 kg/ha. Subsequent trials confirmed the beneficial effects of SoyOil 937 with chlorothalonil at rates as low as 0.84 kg/ha. This discovery offers the potential to reduce the tonnage of chlorothalonil used on peanuts in Virginia by as much as 30%.

The Future

Reducing the need for pesticides in agriculture continues to be a challenging and difficult endeavor. While the public strongly supports programs to maintain an ecological balance in nature, it often fails to recognize that agriculture requires an ecological imbalance to be maintained in favor of crops (1). Our task is to develop and deliver technology that enables farmers to maintain a favorable imbalance for crops without posing hazards to humans or the environment. The Predictive Nematode Assay Program, the peanut leaf spot advisory program, new pesticide chemistry, and spray adjuvants have contributed to achieving these goals by allowing a reduction in pesticide use without sacrificing crop yield or quality.

New research initiatives are now seeking to employ innovations in biotechnology to reduce our need for pesticides. Included are efforts to improve the ability of plants to resist disease and the development of biological agents to replace pesticides. Scientists from universities, the USDA, and private industry are working in concert on a variety of projects that focus on new methods to combat diseases of peanuts. Through these cooperative efforts and partnerships, the future for development and release of new technology for replacement of pesticides appears optimistic.

Table 1. Performance and economic benefits of the Virginia peanut leaf spot advisory program[v]

Year	Spray program[w]	Number of applications	Cost[x] ($/ha)	Percent leaf spot at harvest[y]	Yield[z] (kg/ha)	Value[z] ($/ha)
1987	14-Day	7	168.47	2 b	4,861 a	3,256 ab
	Advisory	5	120.34	3 b	5,185 a	3,422 a
	Check	0	0.00	96 a	4,375 b	3,020 b
1988	14-Day	7	176.95	1 b	4,977 a	3,283 a
	Advisory	3	75.84	4 b	5,080 a	3,443 a
	Check	0	0.00	96 a	3,949 b	2,750 b
1989	14-Day	6	148.70	3 b	4,350 a	3,125 a
	Advisory	5	123.92	6 b	4,299 a	3,096 a
	Check	0	0.00	97 a	2,505 b	1,883 b
1990	14-Day	7	191.82	3 b	4,392 a	3,159 a
	Advisory	5	137.02	5 b	5,001 a	3,741 a
	Check	0	0.00	96 a	4,158 a	3,067 a
Mean	14-Day	6.75	171.49	2 b	4,681 a	3,213 a
	Advisory	4.50	114.28	4 b	4,884 a	3,404 a
	Check	0.00	0.00	96 a	3,747 b	2,658 b

[v] Means in a given year and column followed by the same letter are not significantly different at $P = 0.05$ according to Duncan's multiple range test. Data are the mean of four replications, except for unequal replication of yield and value for treatments in 1990.

[w] Chlorothalonil at 1.26 kg/ha was applied with three $D_3$23 nozzles per row; spray nozzles delivered 140 L/ha at 345 kPa of pressure. The 14-day program began about 56 days after planting and was continued at 14-day intervals until 14–21 days prior to harvest. Sprays were applied at times specified by the program.

[x] Based on estimates of variable and fixed costs provided by the farm management staff, Southeast District, Virginia Cooperative Extension Service.

[y] Visual estimates of percentage of leaflets with early leaf spot.

[z] Yield of peanuts at 7% moisture (w/w) and grade in accordance with Federal-State Inspection Service methods were used to determine value.

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